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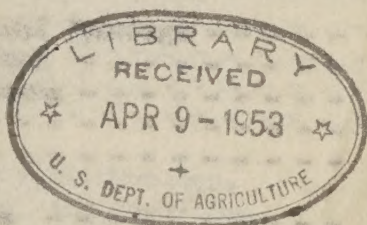


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2 U.S. UNITED STATES DEPARTMENT OF AGRICULTURE
Bureau of Agricultural Engineering Division of Drainage
S. H. McCrory, Chief

Introduction -----
Station Farm -----
Rainfall and Run-off Measurements -----
Measurements of Soil Loss -----
3 0 0
1932 Progress Report on
Climatological Data -----
ENGINEERING EXPERIMENTS CONDUCTED AT THE
Crops -----
SOIL EROSION EXPERIMENT STATION

Experiment No. 1 - Terraces with -----
Run-off and Soil Loss -----
Run-off and Soil Loss -----
Crop Fields -----
Conclusions -----
Experiment No. 2 - Terraces with -----
Description and Object -----
Run-off and Soil Loss -----
Crop Fields -----
Conclusions -----



4/5
In cooperation with the Bureau of Chemistry and Soils,
The Oklahoma A. and M. College and the
Guthrie Chamber of Commerce, Guthrie, Oklahoma.

Experiment No. 3 - Long Terraces with -----
Description and Object -----
Run-off and Soil Loss -----
Crop Fields -----
Conclusions -----
Experiment No. 4 - Long Terraces with -----
Description and Object -----
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Experiment No. 5 - Short Level Terraces with -----
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Conclusions -----
Experiment No. 6 - Terraces with -----
Description and Object -----
Run-off and Soil Loss -----
Crop Fields -----
Conclusions -----

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H. E. Bergschneider, Agricultural Engineer, Oklahoma A. and M. College

Under supervision of

C. E. Ramser, Senior Drainage Engineer

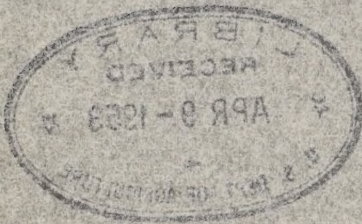
Prepared under the direction of
Lewis A. Jones, Chief of the Division of Drainage and Erosion Control.

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF PLANT INDUSTRY
WASHINGTON, D. C.

PLANT PROTECTION SERVICE

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Report under the direction of
L. A. Jones, Chief of the Division of Plant Industry

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Department No. 8 - Dept of Transportation and Maritime

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Special Agent in Charge - FBI - New York Office

Reported No. 11 - Self Movement Down the Slopes

Approved: _____ Date: _____

I have been thinking about you
 a lot lately. I hope you are
 well. I am doing fine.
 Love,
 John

Document 20.12 – Principles of Social and Political Change

... April 2004 ...

and Untreated Cultivated Watershed

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Number

T i t l e

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T i t l e

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- Police officer James Edward O'Connell, 40 years old, 11111 St. Louis, Mo. 63101, 11111 St. Louis, Mo. 63101.

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- William J. O'Connell, 40 years old, 11111 St. Louis, Mo. 63101, 11111 St. Louis, Mo. 63101.

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- James J. O'Connell, 40 years old, 11111 St. Louis, Mo. 63101, 11111 St. Louis, Mo. 63101.

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- John J. O'Connell, 40 years old, 11111 St. Louis, Mo. 63101, 11111 St. Louis, Mo. 63101.

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14	- Index of names of the different kinds of animals, birds, and plants.

I N T R O D U C T I O N

Study of the economical control of soil erosion in its various phases is the primary objective of the Bureau of Agricultural Engineering on the Red Plains Soil Erosion Experiment Station. Investigations to determine the rate and per cent of run-off from the terraced and unterraced farm lands, coupled with determinations of the soil losses from the same areas, are of paramount importance. These investigations are expanded to show the effects of various land slopes and soil conditions. The data from such experiments will ultimately define a proper and economical basis for decisions regarding the grade, size, vertical spacing, and permissible length for terraces. In addition they will, by comparing soil and water losses from terraced and unterraced areas, serve to demonstrate the economic necessity for terracing farm lands. The efficacy of terraces as conservers of soil moisture, by such design that all rain water is retained, is studied on various soil conditions. Terraces are studied in relation to their effect upon normal farm operations when conducted either parallel to or across the terrace ridges. All operations are conducted with modern farm machinery, the data obtained thus dictating desirable changes in machinery to be used on terraced land, and furnishing a means whereby the most desirable shape of terrace cross section may be determined for various land slopes.

The first questions asked by the landowner interested in terracing concern the probable cost and most efficient methods of terrace construction. Such inquiries can be answered definitely only through experience gained under a wide variety of conditions. Accordingly, accumulations of data showing the cost of building and maintaining terraces on different slopes, soils and surface conditions, are being made and will serve the threefold purpose of pointing out improvements in terracing machines, developing efficient methods of construction, and establishing a definite cost index upon which accurate estimates may be based. Experimental effort is also being directed toward the design of terrace outlet protection devices which may be cheaply installed and toward the development of methods for the disposal of water from terraced fields. Check dams and soil saving dams, in their role of halting and reclaiming gullies, are studied extensively for possible improvements in design and construction.

S t a t i o n F a r m

The Red Plains region covers most of the western half of Oklahoma, northwest central Texas, and a small portion of southern Kansas. The Red Plains Soil Erosion Experiment Station Farm, selected as typical of the more erosive phases of this region, is located 5 miles south of Guthrie, Logan County, Oklahoma. This farm, comprising 160 acres of rolling land, was opened under the Oklahoma Homestead Act of 1889, during

The following information was obtained from the records of the
 Department of the Interior, Bureau of Land Management, for the
 period from 1900 to 1909. The records show that the
 following lands were acquired by the United States
 Government during the above period:

1. The following lands were acquired by the United States
 Government during the above period:

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10. The following lands were acquired by the United States
 Government during the above period:

APPENDIX

The following information was obtained from the records of the
 Department of the Interior, Bureau of Land Management, for the
 period from 1910 to 1919. The records show that the
 following lands were acquired by the United States
 Government during the above period:

1. The following lands were acquired by the United States
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9. The following lands were acquired by the United States
 Government during the above period:

10. The following lands were acquired by the United States
 Government during the above period:

the famous run of that year. Severe erosion had taken place at the time the farm was leased for experimental use.

Topographic and soil surveys show that the slopes on the farm vary from two to eight per cent with a maximum difference in elevation of 78 feet, and that two principal soils are available. Kirkland fine/ sandy loam soil occurs, (see farm map, Figure 1) on the smoother divides in the central, south central, and northwestern sections of the farm. The Vernon fine sandy loam soil occurs on the slopes forming the remainder of the farm.

An erosion survey of the farm proves that, of 70 acres of cultivated land, 68 acres are affected by erosion while the other two acres are buried under from 6 to 24 inches of erosional debris. Soil planation over 48 per cent of the cultivated land varies from one to ten inches. The remainder of the cultivated land, with the exception of the buried two acres, is completely denuded to depths varying from 10 inches to several feet.

Rainfall and Run-off Measurements

The intelligent design of any channel intended to convey excess rainwater from the fields must be based upon a definite knowledge of the intensity and amount of rainfall and run-off.

Three recording rain gages located as indicated on the farm map (Figure 1) measure the amount of rainfall at any instant to the nearest 0.01 inch and the time to the nearest minute can be estimated from the records charts. The daily rainfall records of these gages for the years 1931

for the year 1931

the amount of the loss.

the firm was leased for experimental use.

the following information:

There were four men in all at the time I was there. One of them was a white man, one was a black man, one was a Chinese man, and one was a Japanese man. They were all dressed in military uniforms.

To receive the full benefit of the new system, it is essential that the system be used in a consistent manner.

Continued from page 10

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changed. The retention of the subject was with the exception of the
subject was not to be changed in any way.

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temperatures of laboratory fermenters that the culture temperature will

Source: *Journal of the American Medical Association*, 1964, 191: 1251-1252.

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1942-1943. The daily rainfall records of these years for the years 1941

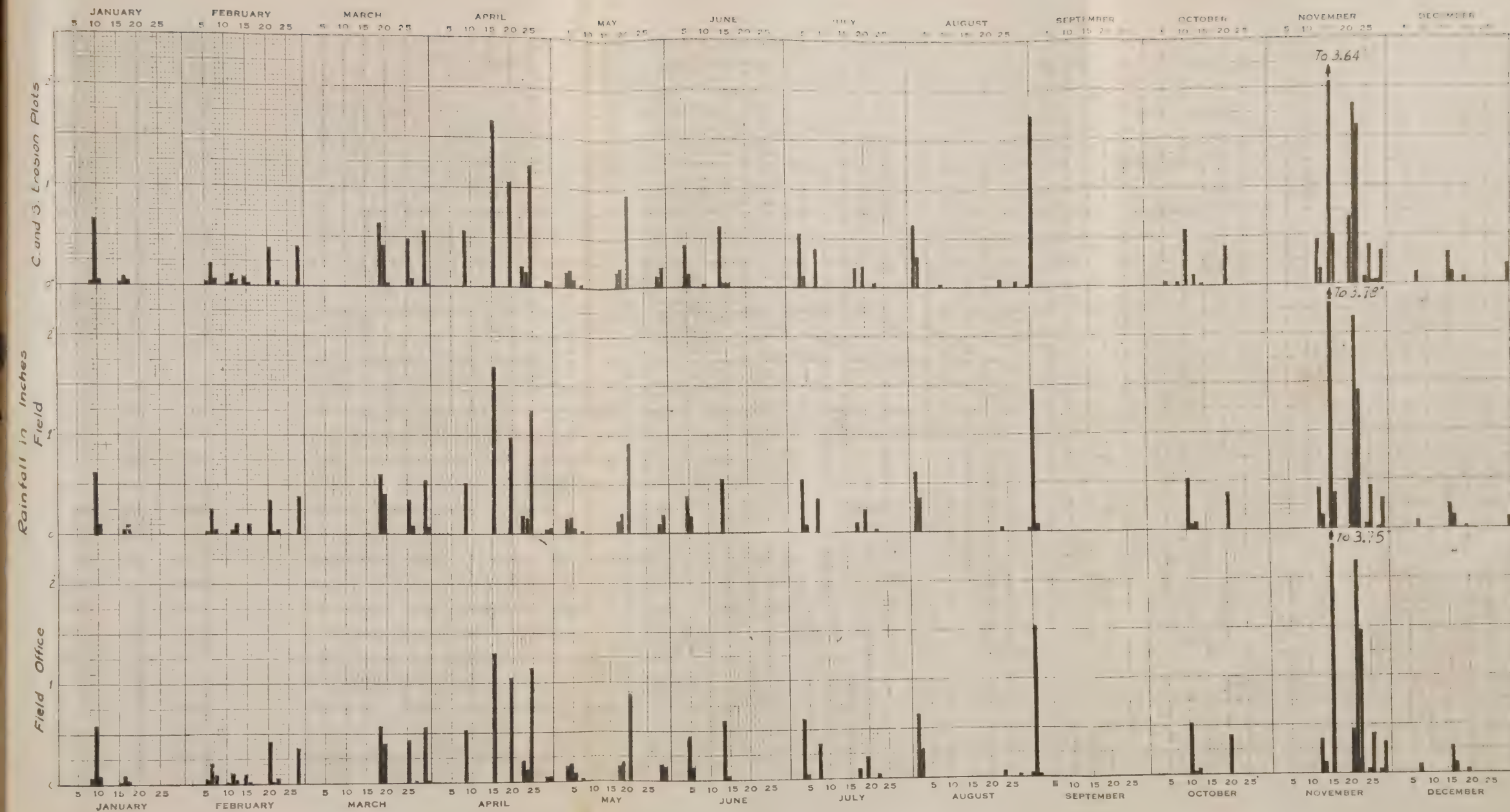


Fig. 2 - Record of daily precipitation on the Red Plains Soil Erosion Experiment Station for the year 1931

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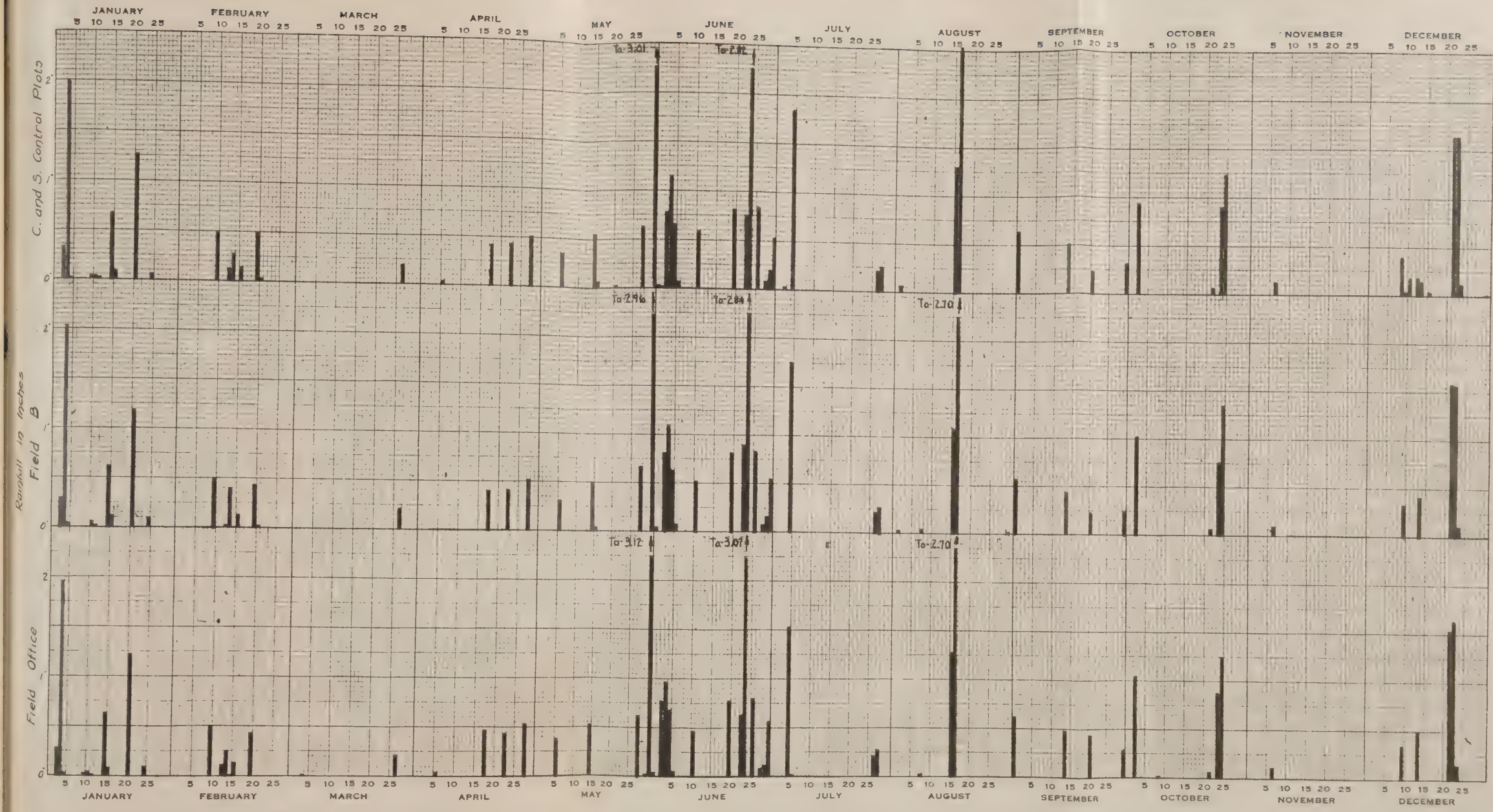
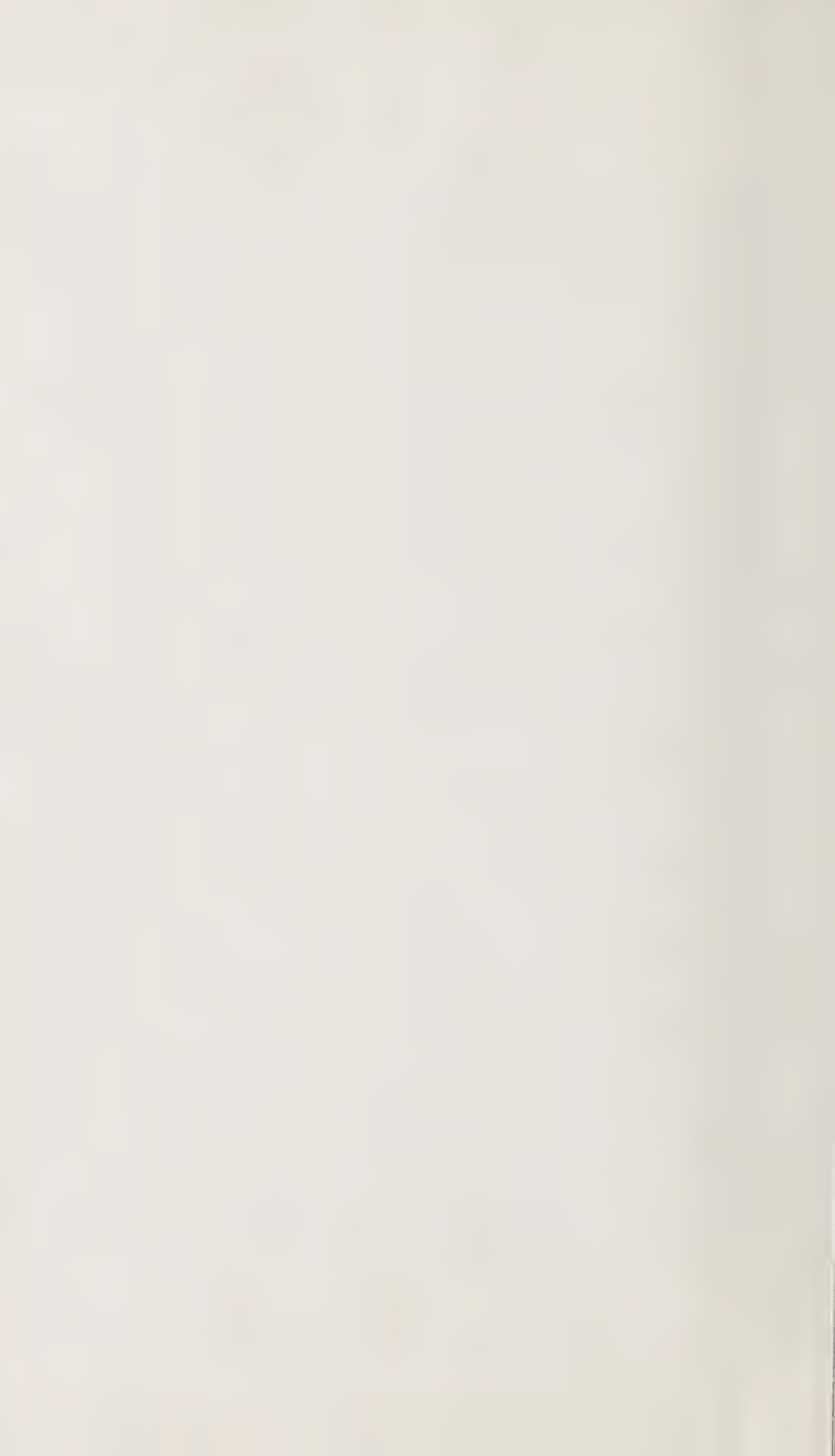


Figure No. 3 - Record of daily precipitation on the Red Plains Soil Erosion Experiment Station for the year 1932



and 1932 are given in Figures 2 and 3. Further checks of the distribution of rainfall over the farm are made by standard weather bureau rain gages located at various points, see map (Figure 1).

The measurement of run-off is accomplished by units consisting of a Parshall measuring flume combined with an automatic water level recorder (Figures 4 and 5). The charts from these recorders indicate the water stage at any instant to the nearest 0.01 foot and the time to the nearest minute. Tables giving the discharge of the Parshall measuring flume for any standard width at any given waterstage have been prepared from extensive laboratory tests and are used in conjunction with the charts from the automatic water level recorders to prepare hydrographs of run-off. The selection of the Parshall measuring flume was made in preference to other flow measuring instruments for the following reasons:

1. The flume measurements are not appreciably affected by the velocity of approach and as a result it is not necessary to store water to eliminate this factor.
2. A deep outlet channel below the flume is not needed since the discharge is affected only by extreme back-water conditions.
3. The concentration of water and consequent increase in velocity at the throat of the flume tends to carry away any soil or drift which is brought to this section by the slow moving water in the terrace channel.

and 1931 are given in Figure 3 and 4. The location of the stations
is indicated on the map by a line with points. The points are
located at various points, see map (Figure 1).

The measurement of the velocity of the water is made by
the use of a float. The float is a small piece of wood, about
10 cm. long and 2 cm. wide. It is placed in the water and the
velocity of the water is measured by the distance it travels in
a given time. The float is placed in the water at the station
and the time is measured by a watch. The distance is measured
by a tape. The velocity is calculated by the formula
 $V = \frac{D}{T}$ where V is the velocity, D is the distance, and
 T is the time. The velocity is measured in cm. per sec.
The measurement of the water level is made by a staff.
The staff is a vertical pole, about 2 m. long, with a
scale on it. The water level is measured by the height of the
water on the staff. The staff is placed in the water and the
height is measured by a tape. The water level is measured in
m. The measurement of the water temperature is made by a
thermometer. The thermometer is placed in the water and the
temperature is measured by the scale on the thermometer. The
temperature is measured in degrees Celsius.

1. The time measurements are not necessarily

affected by the velocity of approach and as a result it is

not necessary to state what is the water level.

2. A deep outlet channel below the time is not

needed since the discharge is allowed only by surface flow.

water conditions.

3. The construction of water and consequent in-

crease in velocity at the outlet of the time leads to a

very high velocity at the outlet of the time leading to the

slow moving water in the bottom channel.

Figure 4: Parshall measuring flume of two foot throat width with wing walls and recorder shelter.

There is a great deal of work to be done
in the way of improving the quality of the
work.

M e a s u r e m e n t s o f S o i l L o s s e s

Measurements of the amount of soil loss are made with the Ramser silt Sampling Device. A wooden box (Figures 6 and 7) is used to trap all the heavier material in the run-off water. The size of this box varies with the width of the Parshall measuring flume as follows:

For a flume of one foot throat width the box is 16 feet long, five feet wide and two feet deep below the crest of the outlet weir; and for a flume of two foot throat width the box is 16 feet long, 8 feet wide, and 2 feet deep below the crest of the outlet weir (Figure 6). The amount of material dropped in the box is measured directly while the amount escaping in the water over the rectangular weir at the outlet end of the box is determined by a sampling device which takes a proportionate amount of the discharge at any stage of flow through a notch in the side of the box (Figure 6). The water from this notch of $1/2$ inch width enters a divisor box where it is again divided by means of two small weirs. The water through the larger or 3 inch weir is wasted while that from the $1/2$ inch weir is conducted into a storage tank (Figure 7). The silt content of the water in the tank is determined and applied to the total volume passing over the outlet weir to determine the amount of dry soil in the discharge water. This figure when added to the material caught in the box gives the total amount of soil loss from the drainage area for any particular rain.

SECRET

Amounts of the amount of sold loss are made with the

Now a frame of one foot throat width the box is 18

Two small canals. The water through the larger is 2 feet wide at
width across a distance of about 12 to 15 feet. It is about 12 feet
at the top (about 12). The water from this canal is 12 feet
of the drainage at any stage of flow through a canal in the line
determined by a small dam which is about 10 feet wide and
water over the drainage is 12 feet wide and 12 feet deep. The
is not but is somewhat irregular with the water passing in the
at the outlet only 12 feet. The water is somewhat irregular
but is 12 feet deep, 12 feet wide, and 12 feet deep below the water
the outlet water is 12 feet wide and 12 feet deep below the water
feet deep. The water which has the first water below the outlet is

... ..

Figure 6: Silt box and silt sampling unit for two foot
Parshall measuring flume. Divisor box, waste
weir, and sample storage tank in right front
of view.

There is also a small building on the right side of the road, which is used for the storage of the fire engine. The building is made of wood and is in good condition. The fire engine is a small, red, two-wheeled vehicle with a pump and hose. It is parked on the dirt road next to the building. The road is made of dirt and is in good condition. The road is surrounded by trees and bushes. The sky is blue and clear. The sun is shining brightly. The overall scene is peaceful and quiet.

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Climatological Data

Distribution of rainfall over the years 1931 and 1932 is shown in Figures 2 and 3. The total rainfall of 27 inches on the station farm during 1931 is approximately six inches below the mean. At the first of November the rainfall deficiency amounted to about 12 inches but a total precipitation of 10 inches during the remainder of the year cut this deficiency in half. The abnormality of the rainfall year 1931 is further emphasized when consideration is given to the fact that the spring months are normally those of greatest rainfall.

The rainfall occurrence during 1932 was more nearly normal, although there was an excess of 3.65 inches above the yearly mean. June was a month of great excess rainfall with other marked excesses in January, July and December. Deficiencies occurred in March, April, September and November. The rainfall for the other four months of the year was reasonably near the average. The 14.00 inches of intense rainfall which fell during the period May 31st to July 5, 1932 constituted 39 per cent of the year's rainfall and produced approximately 91 per cent of the year's soil losses.

Monthly wind movement and average velocity in miles per hour for the four years of record are given in Table No. 1. These averages for the year 1932 were below normal.

Crops

The Dixie three year rotation of corn, oats, cotton, combined with green manure and cover crops constitutes the basic farming system used

TABLE No. _____

Total Wind Movement and Average Velocity in Miles per Hour
For Monthly Periods Beginning March 1929
on Guthrie Soil Erosion Experiment Farm.

	1929		1930		1931		1932	
	Total	Aver-	Total	Aver-	Total	Aver-	Total	Aver-
		age		age		age		age
	Movement:	Velo-	Movement:	Velo-	Movement:	Velo-	Movement:	Velo-
	city	city	city	city	city	city	city	city
	Miles	M/P/H.	Miles	M/P/H.	Miles	M/P/H.	Miles	M/P/H.
January	No Record		8512.8	11.4	5379.5	7.2	8491.3	9.3
February	3344.3	8.3	7334.6	10.9	4631.4	7.4	7175.7	9.6
March	8417.3	11.3	8549.9	11.3	8974.2	12.1	8697.2	11.7
April	9508.1	13.3	8074.3	11.3	6921.4	9.5	7721.8	10.8
May	8009.5	10.7	8103.6	10.8	7928.9	10.7	7495.5	9.7
June	8322.6	12.2	7762.8	10.7	7374.7	10.2	5162.7	7.3
July	6711.9	8.9	7395.5	9.9	4362.9	5.9	6263.7	8.5
August	6969.2	9.3	5932.8	8.0	5868.0	7.9	7304.6	9.7
September	5851.6	8.1	6722.2	9.2	8522.0	11.9	5105.7	6.9
October	5733.1	7.3	6273.4	8.4	7932.0	10.6	6629.1	9.3
November	5279.8	8.4	8706.6	9.3	6307.0	8.4	5050.7	7.0
December	6012.8	8.3	5424.1	7.2	6521.0	8.9	6694.2	8.7
Yearly								
Total	75532.0		86794.6		81208.0		73232.0	
Monthly								
Average	6271.0	9.6	7232.8	9.8	6767.3	9.2	6037.5	9.1

TABLE No. 2

Record of Crop Rotations
Red Plains Soil Erosion Experiment Station

Field or Plot Number	1929		1930		1931		1932		1933		1934		1935		1936		1937		1938	
	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Field A	Cotton	Rye	Cotton	Rye	Corn	Cowpeas	Oats	Cowpeas	Corn	Cowpeas	Oats	Cowpeas	Cotton	Wheat	Corn	Cowpeas	Oats	Cowpeas	Cotton	Wheat
Field B	Cotton	Cowpeas	Oats	Cowpeas	Cotton	Wheat	Corn	Cowpeas	Oats	Cowpeas	Cotton	Wheat	Corn	Cowpeas	Oats	Cowpeas	Cotton	Wheat	Corn	Cowpeas
Field C	Cotton	Rye	Kaffir	Cowpeas	Oats	Cowpeas	Cotton	Wheat	Corn	Cowpeas	Oats	Cowpeas	Cotton	Wheat	Corn	Cowpeas	Oats	Cowpeas	Cotton	Wheat
Plot C ₁	Cotton	Rye	Kaffir	Cowpeas	Oats	Cowpeas	Cotton	Wheat	Corn	Cowpeas	Oats	Cowpeas	Cotton	Wheat	Corn	Cowpeas	Oats	Cowpeas	Cotton	Wheat
Plot G			Cotton	Wheat	Cowpeas		Cotton	Wheat	Cowpeas		Cotton	Wheat	Cowpeas		Cotton		Cowpeas		Cotton	Wheat
Plot G ₁			Cotton	Wheat	Cowpeas		Cotton	Wheat	Cowpeas		Cotton	Wheat	Cowpeas		Cotton		Cowpeas		Cotton	Wheat
Plot H			Cotton	Wheat	Corn		Corn		Kaffir		Corn		Kaffir		Corn		Kaffir		Corn	
Plot 13	Cowpeas	Rye	Cotton	Wheat	Cowpeas	Wheat	Cotton	Wheat	Cowpeas	Wheat	Cotton	Wheat	Cowpeas	Wheat	Cotton	Wheat	Cowpeas	Wheat	Cotton	Wheat
Plot 14	Cowpeas	Rye	Cotton	Wheat	Cowpeas	Wheat	Cotton	Wheat	Cowpeas	Wheat	Cotton	Wheat	Cowpeas	Wheat	Cotton	Wheat	Cowpeas	Wheat	Cotton	Wheat
Plot 15	Cowpeas	Rye	Cotton	Wheat	Cowpeas	Wheat	Cotton	Wheat	Cowpeas	Wheat	Cotton	Wheat	Cowpeas	Wheat	Cotton	Wheat	Cowpeas	Wheat	Cotton	Wheat
Plots 1 to 12 are shown	separately under Sub-project S.E. 1.9																			

on the fields devoted to engineering experiments. The record of crop rotation is given in Table 2. Discussions of yields and other cropping features are included with the various experiments.

varied from 12.0 per cent for Terrace 1-A to 5.5 per cent for Terrace 6-A.

EXPERIMENT NO. 1

Terraces with Different Vertical Spacings.

of the field, showing the location of the terraces, and the slope of the land.

This experiment affords information concerning the proper

vertical spacing for terraces located on the particular soil and slope.

Terraces 1-A to 6-A, located in Field A in the northwest corner of the farm, (See map, Figure 1), are included. Each terrace is 700 feet in length with a uniform grade of four inches per 100 feet. Starting with Terrace 1-A and going up the slope and the vertical interval between terraces is as follows: two feet, three and one half feet, five feet, five feet,

three and one half feet and two feet. The fact that the various intervals are repeated in reverse order makes possible the elimination of variations

due to differences in soil and slope by averaging the results obtained for

each pair of terraces with same spacing. The average slope of land is

about 5.5 per cent. The land served as wooded pasture prior to breaking

out for experimental use. Data pertaining to the dimensions and drainage

areas of these terraces are given in the first six columns of Table 14.

Complete equipment for measuring run-off and soil losses are installed at the end of each terrace.

Run-off and Soil Losses for Year:

Run-off percentages and soil losses, for the individual

on the basis evolved to engineering experiments. The result of crop
rotation is given in Table II. The rotation of crops and their
features are included with the various experiments.

THESE

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1. The first step is to identify the problem or goal. This involves understanding the current situation, identifying the problem, and setting a clear goal. The goal should be specific, measurable, achievable, relevant, and time-bound (SMART).

terraces in Field A, by crop seasons and for the total years 1931, and 1932, are given in Tables 13 and 14. Run-off data for 1930 is in Table 12. The per cent of the total rainfall which ran off during the year varied from 18.0 per cent for Terrace 4-A to 27.6 per cent for Terrace 6-A. The tendency toward a higher percentage run-off on the two upper terraces was also present in 1931. This tendency may be due to the upper reaches of the field having been more affected by erosion prior to breaking out for experimental use.

Inspection of the records of percentage run-off for the three years of record shows consistently that this percentage decreases as the vertical spacing between terraces is increased. This fact was particularly noticeable for the year 1932 when the percent of the years rainfall which appeared as run-off was 26.1 per cent for the average of the two terraces with two foot vertical spacing, 23.8 per cent for the three and one half foot spacing, and 18.9 per cent for the five foot spacing. It appears that this variation may be caused by the increased distance down the slope between terraces and therefore increased time for percolation above the terraces of large vertical spacing.

Study of soil loss figures for the years 1931 and 1932 show important difference. Soil losses for the year 1931 were 2.74 tons per acre for the average of the two terraces for two foot vertical spacing, 3.96 tons per acre for the three and one half foot spacing and 4.93 tons per acre for the five foot spacing or an average increased loss of about one ton per acre for each additional foot of vertical spacing.

For the year 1932, the soil loss on the average of the two foot spacings was 3.57 tons per acre, 3.37 tons per acre on the 3½ foot spacing, and 3.05 tons per acre on the 5 foot spacing, which indicates a slight decrease in soil loss as the vertical spacing is increased.

The seeming incompatibility of these two years results may be attributed to the great difference in effect on erosion as exerted by clean cultivated row crops and by close growing drilled crops. During 1931 Field A was cropped to corn in contoured rows followed by cowpeas planted in a similar manner. For the year 1932, the field was covered with a well established oat crop during the period May 15th, to July 15th when 39.5 per cent of the year's rainfall occurred, causing 75 per cent of the year's run-off. The row crop of 1931 permitted the water flowing down the slope between terraces to gain velocity as the slope distance increased thus forming small gullies. See Figure 8, which results in increased erosion on the larger spacings. The close root mat of the oat cover existing in 1932 checked the velocity of flow down the slope, forcing the water to filter slowly past the oat plants. This action tended to make the rate of erosion practically constant on all the terraces regardless of vertical spacing. The slight tendency toward a reduction of soil loss per acre with increased vertical spacing may have been caused by the decreased percentage of run-off on the larger intervals as previously discussed. The rains which occurred in 1932 on the ~~gnt~~ highly protective oat crop were frequent, and very intense, while those occurring in 1931 on the clean cultivated row crop were few in number and not of great intensity. It seems probably, therefore, that the spread between the effectiveness of

Figure 8: Collier found between A textured of other events
by John Collier 1911.

these two crops in erosion prevention efficiency would have been greater under comparable conditions of rainfall.

Run-off and Soil Loss by Storms:

In Table 3 are listed measurements of rainfall, run-off and soil losses for principal ~~max~~ storms occurring during the year 1932. The storm of May 31st represented the highest sustained rainfall intensities of the year, ranging from 6.00 inches per hour for the five minute intensity to 3.84 inches per hour for the 30 minute intensity. The storm total precipitation was 3.12 inches. The intensities of run-off produced by these rainfall intensities were not excessively high, due to the ground being very dry at the time of the storm and also to the close cover of growing oats. This storm marked the beginning of the series which produced the bulk of the year's rainfall and run-off as previously discussed.

The maximum run-off intensities for the year 1932 were caused by the storm of June 24th (see Figure 9) for hydrographs and rainfall curves with a maximum five minute intensity of 4.60 inches per hour and a 30 minute intensity of 3.76 inches per hour. Due to the ground being saturated by previous rains, the percentage and intensity of run-off were ~~glt~~ higher than for the rain of May 31st, which was greater in both volume and intensity. The effect of the close oat cover in reducing the percent run-off and soil loss per acre on the terraces of wider spacing is particularly noticeable for these two storms.

The rain of 1.01 inches occurring on October 3rd, produced the highest five minute intensity, 6.32 inches per hour, yet recorded at

Terraces 1-A to 6-A With Different Vertical Spacings
Measurements of Rainfall, Run-off, and Soil Loss For Principal Storms During the Year 1932
Red Plains Soil Erosion Experiment Station Near Guthrie, Oklahoma

Date Of Storm	Average Rates Of Rainfall					Total Rainfall	Maximum Rates Of Run-off												Total Run-off In Per Cent of Total Rainfall						Soil Loss In Tons Per Acre						Remarks (Crops, Soil, Etc)	
	5	10	15	20	30	For Storm Period	1-A		2-A		3-A		4-A		5-A		6-A		1-A		2-A		3-A		4-A		5-A		6-A			
	Min.	Min.	Min.	Min.	Min.	Sec.	Feet:In/Hr	Feet:In/Hr	Feet:In/Hr	Feet:In/Hr	Feet:In/Hr	Feet:In/Hr	Feet:In/Hr	Feet:In/Hr	Feet:In/Hr	Feet:In/Hr	Feet:In/Hr	Feet:In/Hr	Feet:In/Hr	Feet:In/Hr	Feet:In/Hr	Feet:In/Hr	Feet:In/Hr	Feet:In/Hr	Feet:In/Hr	Feet:In/Hr	Feet:In/Hr	Feet:In/Hr	Feet:In/Hr			
January 4	0.48	0.42	0.40	0.36	0.30	2.26	a	a	0.16	0.28	0.16	0.16	0.30	0.32	0.30	0.22	d	d	a	5.0 ^b	5.0 ^b	5.0 ^b	5.0 ^b	5.0 ^b	a	0.05	0.05	0.07	0.11	0.11	Cutting of corn stalks was com-	
" 15	0.36	0.36	0.32	0.30	0.26	0.73	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	pleted November 11, 1931. Field	
" 21	0.60	0.60	0.56	0.51	0.44	1.22	0.20	0.34	0.20	0.35	0.32	0.32	0.40	0.43	0.40	0.29	0.35	0.26	67.0	70.7	36.6	77.5	48.0	40.0	a	0.32	0.23	0.57	0.37	0.21	was plowed on February 6, 1932	
Feb. 10	1.86	1.60	1.30	1.00	0.80	0.50	a	a	a	a	a	a	a	a	0.01	0.01	a	a	a	a	a	3.4	a	a	a	a	a	a	a	a	with one-way disc plow. Field	
" 31	6.00	4.68	4.20	4.35	3.84	3.12	1.27	2.14	1.39	2.46	d	d	d	d	3.52	2.54	2.90	2.15	37.2	51.0	35.0 ^b	35.0 ^b	39.2	33.5	1.38	0.79	0.78	0.59	0.75	0.61	was disced and drilled to oats on	
" 3	0.96	0.84	0.64	0.63	0.52	0.77	a	a	a	a	a	a	0.04	0.05	a	a	a	a	a	a	a	8.9	a	a	a	a	a	a	a	a	February 24, 1932. The crop was	
" 4	2.28	1.86	1.68	1.44	1.14	0.97	0.49	0.83	0.54	0.96	0.92	0.93	0.84	0.90	1.15 ^c	0.83 ^c	0.99	0.73	76.3	88.4	84.5	62.7	50.0	41.4	0.13	0.25	0.29	0.15	0.22	0.13	damaged by winds and lack of rain-	
" 5	2.11	1.79	1.77	1.53	1.03	0.74	0.22	0.37	0.37	0.66	0.64	0.64	0.71	0.76	0.92	0.66	0.84	0.62	73.7	62.8	76.8	46.5	37.3	28.4	0.13	0.13	0.13	0.06	0.08	0.04	fall during March. Oats were cut	
" 23	1.34	1.15	1.09	1.03	0.97	0.63	d	d	0.09	0.16	0.14	0.14	0.18	0.19	0.07	0.05	d	d	20.0 ^b	18.7	37.9	22.6	11.7	20.0 ^b	a	a	a	0.01	0.01	a	June 14, 1932. Oat stubble was	
" 24	4.60	4.10	4.17	3.88	3.76	3.07	d	d	1.84	3.26	3.29	3.31	3.24	3.48	4.82	3.47	4.00	2.96	80.0 ^b	86.0	79.5	85.3	66.0	65.4	1.51	1.17	1.01	0.70	0.95	0.94	plowed under with one-way disc	
" 26	0.48	0.36	0.32	0.30	0.28	0.80	0.14	0.24	0.05	0.09	0.12	0.12	0.12	0.13	0.05	0.04	d	d	10.0 ^b	10.0 ^b	10.0 ^b	10.0 ^b	10.0 ^b	10.0 ^b	0.01	0.11	0.01	0.01	0.01	0.01	plow on July 12, 1932. Cowpeas	
" 30	1.73	1.09	0.97	0.90	0.72	0.42	0.35	0.59	0.25	0.44	0.64	0.64	0.58	0.62	0.92	0.66	0.71	0.52	92.0	63.8	83.0	74.5	60.7	44.7	0.08	0.04	0.47	0.05	0.05	0.03	were planted in contoured rows on	
July 5	4.46	3.18	2.51	2.05	1.36	1.56	1.23	2.05	1.25	2.22	2.26	2.26	2.43	3.94	2.84	3.18	2.36	75.3	69.0	85.3	67.5	56.6	48.0	0.31	0.25	0.36	0.27	0.33	0.21	July 14, 1932. Green cowpeas were		
August 16	2.28	2.22	2.20	1.86	1.38	3.98	0.14	0.24	0.43	0.76	0.25	0.25	0.92	0.99	0.80	0.58	1.15	0.85	25.6	34.3	4.7	31.2	16.5	17.8	0.01	0.30	0.07	0.47	0.21	0.31	plowed under on October 7, 1932	
October 3	6.32	4.02	3.05	2.51	1.79	1.01	0.30	0.51	0.74	1.31	0.37	0.37	1.15	1.23	0.77	0.55	0.77	0.56	25.8	41.6	19.8	47.5	33.6	23.2	0.01	0.16	0.10	0.24	0.15	0.10	with moldboard plow.	
" 25	3.90	3.47	2.64	2.01	1.36	2.12	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a		
" 23	0.72	0.54	0.44	0.42	0.38	2.63	d	d	0.12	0.21	0.18	0.18	0.20	0.21	0.14	0.10	0.18	0.13	5.0 ^b	5.0 ^b	5.0 ^b	5.0 ^b	5.0 ^b	5.0 ^b	a	0.01	0.02	0.01	0.06	0.10		
Terrace Land Slope Vertical Spacing Grade Length																																
1-A 5.35 2.0 4"/100' 700'																																
6-A 5.60 2.0 4"/100' 700'																																
2-A 5.46 3.5 4"/100' 700'																																
5-A 5.76 3.5 4"/100' 700'																																
3-A 5.45 5.0 4"/100' 700'																																
4-A 5.58 5.0 4"/100' 700'																																
Note:																																
a = No run-off or no soil loss																																
b = Total run-off estimated																																
c = Maximum rate of run-off estimated																																
d = No record due to instrument failure																																

Note:

a = No run-off or no soil loss

b = Total run-off estimated

c = Maximum rate of run-off estimated

d = No record due to instrument failure

The cover consisted
of oats stubble.

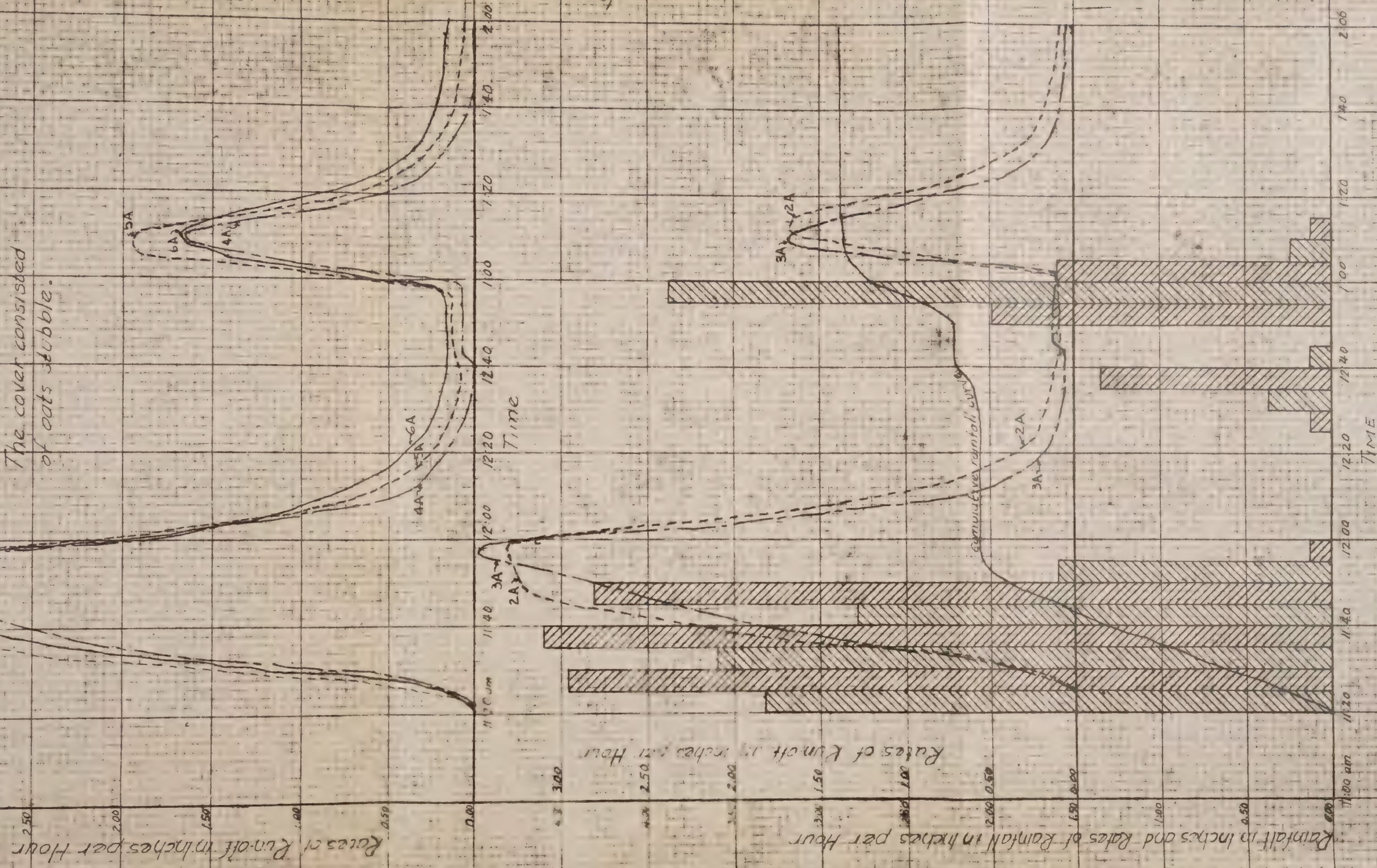


Figure 1. Cumulative rainfall and rates of rainfall and run-off for terraces
700' long, with a grade of 4" per 100', and different vertical spacings
as follows: 1A and 6A = 2 feet, 2A and 5A = 3.5 feet, 3A and 4A = 5 feet.
Rain of June 24, 1932.

this station. The intensities for longer periods were not excessive, (Rainfall intensity and accumulation, and rates of run-off are shown graphically in Figure 10). Percentage and intensity of run-off and amount of soil loss per acre were not excessive due to the dry and absorptive condition of the soil. During this storm the field was supporting a clean cultivated row crop of cowpeas and as a result was subject to the formation of small gullies which increased in size as the vertical spacing between terraces increased. This resulted in increased soil loss per acre as the vertical spacing between terraces was increased, which duplicated the results obtained during the storms of 1931, when the field was cropped in a similar manner.

Crop Yields:

A crop history of the field for the year 1932 is given in Table 3 and crop yields for the years 1931 and 1932 in Tables 13 and 14. The corn yields for 1931 were very low because the corn crop was practically destroyed by hot winds at tassel stage. In 1932 throat crop was damaged by wind cutting but could not be considered a total loss. The corn yield per acre in 1931 averaged 6.9 bushels per acre on the disturbed area, that is, the terrace ridge and channel, and 5.3 bushels per acre on the interval or area not disturbed by the terracing operation. Field harvesting for 1932 did not divide the oat crop according to disturbed and not disturbed areas, but sample strips harvested perpendicular to the contour by the Bureau of Chemistry and Soils indicated a greater yield on the disturbed areas.

in a similar manner.

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A crop history of the field for the year 1911 is given in
 Table I and crop yields for the years 1911 and 1912 in Table II and III.
 The data yields for 1911 were very low because the soil was very dry and
 the crop was very small. In 1912 the soil was very dry and the crop was
 very small. The data yields for 1912 were very low because the soil was very
 dry and the crop was very small. The data yields for 1912 were very low
 because the soil was very dry and the crop was very small. The data yields
 for 1912 were very low because the soil was very dry and the crop was very
 small. The data yields for 1912 were very low because the soil was very dry
 and the crop was very small. The data yields for 1912 were very low because
 the soil was very dry and the crop was very small. The data yields for 1912
 were very low because the soil was very dry and the crop was very small.

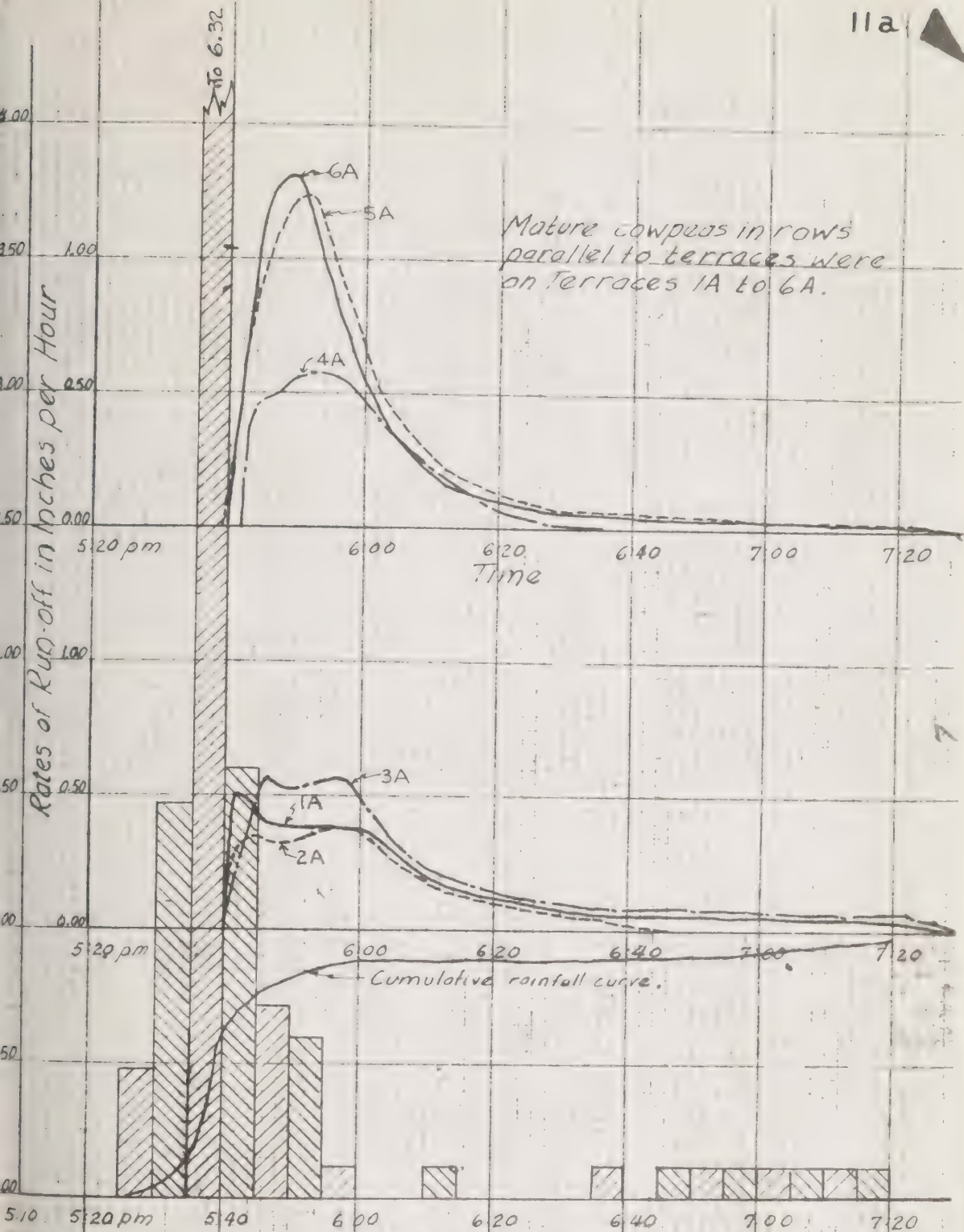


Figure 11 - Cumulative rainfall and rates of rainfall and runoff for terraces 700' long, with a grade of 4% per 100', and different vertical spacings as follow: 1A and 6A = 2 feet, 2A and 5A = 3.5 feet, 3A and 4A = 5 feet. Rain of Oct. 9, 1952.

Conclusions:

It is not desirable to base definite conclusions upon the data now available on this experiment. The following trends have been well outlined, however:

1. The percent of the rainfall which appears as run-off decreases as the vertical spacing between terraces increases, due to the increased opportunity for percolation.

2. Soil loss in tons per acre increases directly with the vertical spacing between terraces when the ground is bare, is fallow, or cropped to clean cultivated row crops.

3. When the field is cropped to close growing drilled crops, such as oats, the soil loss is not greatly influenced by the vertical spacing.

Conclusions

It is not desirable to base definite conclusions upon the data now available on this experiment. The following trends have been well outlined, however:

1. The percent of the available water capacity of soil decreases as the vertical spacing between furrows increases, due to the increased opportunity for percolation.
2. Soil loss is not yet determined directly from the vertical spacing between furrows when the ground is left, or covered, or covered in place cultivated and covered.
3. When the field is covered in place ground is left, crops, such as oats, the soil loss is not greatly influenced by the vertical spacing.

EXPERIMENT No. 3

Terraces With Different Grades

Description and Object:

The object of this experiment is to determine the effect of the terrace grade on conservation of soil and moisture. This data will indicate the most efficient grade for use in laying out terraces on the particular soil and slope.

Terraces 3-C to 6-C, each 1,500 feet in length and with respective grades of six, four, two and zero inches per 100 feet, comprise the layout for this experiment. They are located on the northeastern slope of the farm. The vertical spacing of 3-C is constant at $3\frac{1}{2}$ feet while that of each of the other three terraces varies from about $4\frac{1}{2}$ feet at the upper end to two feet at the lower end or an average of approximately $3\frac{1}{2}$ feet. The land traversed by the lower five to six hundred feet of each terrace has been in cultivation for many years with some erosion as a result. The remaining portion of the terraces lies on virgin land that was used for pasture prior to experimental use. Data pertaining to dimensions and drainage areas of terraces are given in the first six columns of Table 14. Complete run-off and silt measuring units are installed at the outlet of each terrace.

Run-off and Soil Loss for the Year:

Run-off percentages and soil losses on these terraces for crop seasons and the total year are shown in Table 13 for the year 1931 and Table 14 for the year 1932.

Therefore the present year

EXPERIMENTAL

Experimental Results

General Results

The object of this experiment is to determine the effect

of the various types of construction of soil and subsoil. This case will indicate the most efficient types for use in future soil research on the

particular soil and climate.

Experiments 1-4 in 1922, and 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 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1346, 1347, 1348, 1349, 1350, 1351, 1352, 1353, 1354, 1355, 1356, 1357, 1358, 1359, 1360, 1361, 1362, 1363, 1364, 1365, 1366, 1367, 1368, 1369, 1370, 1371, 1372, 1373, 1374, 1375, 1376, 1377, 1378, 1379, 1380, 1381, 1382, 1383, 1384, 1385, 1386, 1387, 1388, 1389, 1390, 1391, 1392, 1393, 1394, 1395, 1396, 1397, 1398, 1399, 1400, 1401, 1402, 1403, 1404, 1405, 1406, 1407, 1408, 1409, 1410, 1411, 1412, 1413, 1414, 1415, 1416, 1417, 1418, 1419, 1420, 1421, 1422, 1423, 1424, 1425, 1426, 1427, 1428, 1429, 1430, 1431, 1432, 1433, 1434, 1435, 1436, 1437, 1438, 1439, 1440, 1441, 1442, 1443, 1444, 1445, 1446, 1447, 1448, 1449, 1450, 1451, 1452, 1453, 1454, 1455, 1456, 1457, 1458, 1459, 1460, 1461, 1462, 1463, 1464, 1465, 1466, 1467, 1468, 1469, 1470, 1471, 1472, 1473, 1474, 1475, 1476, 1477, 1478, 1479, 1480, 1481, 1482, 1483, 1484, 1485, 1486, 1487, 1488, 1489, 1490, 1491, 1492, 1493, 1494, 1495, 1496, 1497, 1498, 1499, 1500, 1501, 1502, 1503, 1504, 1505, 1506, 1507, 1508, 1509, 1510, 1511, 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2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 21

The run-off for the year 1932, in per cent of the total rainfall varied from 23.3 per cent for level Terrace 6-C to 26.5 per cent for Terrace 4-C with grade of 4 inches per 100 feet. Terrace 3-C with a grade of 6 inches per 100 feet had a lower per cent run-off than 4-C and in 1931 was lower than all but 6-C. Inspection of the map, Figure 1, shows that the drainage area of Terrace 3-C, is narrower at the upper end than the other terraces and that the middle third is much wider due to a decrease in land slope. This concentration of area on a flatter slope would allow the run-off water more time to percolate into the soil before entering the terrace channel and consequently might reduce the per cent run-off.

The per cent run-off on level Terrace 6-C has consistently been less than on the other three terraces in the experiment. This is due, first, to the decreased velocity of flow in the terrace channel with consequent greater opportunity for percolation into the soil and, second, to the pondage effect created by small deltas in the terrace channel, (see Figure 11). These deltas are formed at points of concentrated flow down the interterraced area, (See Figure 12) and are not removed from the channel of the level terrace by the flowing water because of its low velocity.

The effect of these deltas from year to year on the grade of the terrace channels is shown in Figure 13 which gives original profiles of the terrace ridges and channels as run originally in 1929, and as run early in 1933. In Terraces 3-C and 4-C which have the steeper grades and therefore the greatest velocities of flow the present channel grade, as

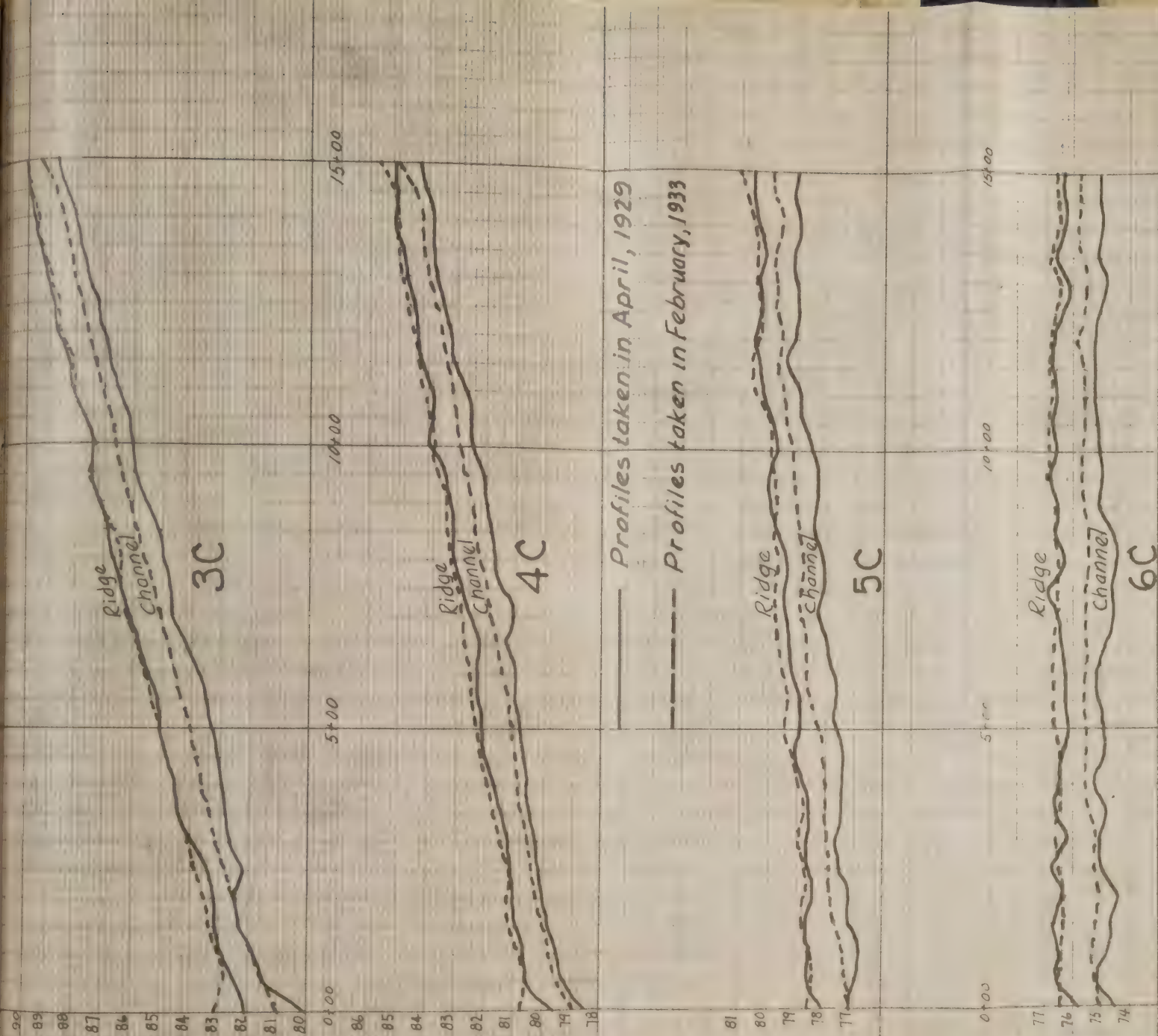


FIGURE 1 - TERRACE PROFILES, FIELD C
 RED PLAINS SOIL EROSION EXPERIMENT STATION

Figure 11: Deposit of silt in channel of Terrace 6-B,
July 7, 1932

For further information at this time please refer to page 12
of the report.

by the lower level line, is practically perfect. In Terrace 3-6
 irregularities occur at points which field observations show to coincide
 with the points and in Terrace 4-6 this effect is much more pronounced.

The lower portions of the channels of Terraces 3-6 and 4-6
 with grades of 3 inches and 4 inches per 100 feet, are subject to a scouring
 effect, see Figure 14. This scouring rapidly removes all debris from the
 channel and would even cut a ditch were the soil not protected.

The following is a list of the soil losses per acre for
 this soil, measured directly with the grade of the terrace. In 1931 the
 loss varied from 1.25 tons per acre on level Terrace 5-6
 to 2.11 tons per acre on Terrace 3-6 with grade of 3 inches per 100 feet.
 In 1932 the loss increased to 1.96 tons per acre on the level terrace and
 25.08 tons per acre on Terrace 3-6.

For the two years of record, Terrace 4-6 with a grade of 3
 inches per 100 feet, has lost 3.4 times as much soil per acre as level
 Terrace 5-6, Terrace 4-6 with grade of 4 inches per 100 feet has lost 2.11

**Figure 12: Gullies between Terraces 2-6 and 3-6 caused by
 concentration of water from contoured rows to
 natural depression. June 8, 1932.**

It showed that the lower 2-6 feet of Terrace 5-6 had cut out until the
 grade was greater than the desired 3 inches per 100 feet. This was care-
 fully corrected and it is believed that as a result the grade of soil loss
 between 5-6 and 4-6 will be considerably lower during the year 1933.
 The soil in the grade of the other three terraces were also corrected
 and records for 1933 will be subject to no error from this source.

of these two 1-2 percent water will not
be very different and will be
about 1.5 percent.

indicated by the lower dotted line, is practically perfect. In Terrace 5-C irregularities occur at points which field observations show to coincide with delta points and in Terrace 6-C this effect is much more pronounced.

The lower portions of the channels of Terraces 3-C and 4-C with grades of 6 inches and 4 inches per 100 feet, are subject to a scouring effect, see Figure 14. This scouring rapidly removes all deltas from the channel and would soon cut a ditch were the outlet not protected.

Data relating to soil loss on these terraces indicate that this loss increases directly with the grade of the terrace. In 1931 (See Table 13) the loss varied from 1.25 tons per acre on level Terrace 6-C to 5.46 tons per acre on Terrace 3-C with grade of 6 inches per 100 feet. For 1932 this loss increased to 4.06 tons per acre on the level terrace and 15.06 tons per acre on Terrace 3-C.

For the two years of record, Terrace 3-C with a grade of 6 inches per 100 feet, has lost 3.9 times as much soil per acre as level Terrace 6-C, Terrace 4-C with grade of 4 inches per 100 feet has lost 2.0 times as much soil, and Terrace 3-C with grade of 2 inches per 100 feet has lost 1.7 times as much soil as Terrace 6-C. Investigations late in 1932 showed that the lower 500 feet of Terrace 5-C had cut out until the grade was greater than the desired 2 inches per 100 feet. This was carefully corrected and it is believed that as a result the ratio of soil loss between 5-C and 6-C will be considerably lower during the year 1933. Inequalities in the grade of the other three terraces were also corrected so that records in 1933 will be subject to no error from this source.

1953

The great increase of soil loss and run-off on these terraces during the year 1932 as compared with 1931 may be explained, first, by the succession of intense rains occurring during the summer of 1932 on saturated ground as compared with scattered small rains during 1931. A second important reason lies in the difference in cover between the two years. A close cover of oats on the field during the spring rain period of 1931 resulted in a minimum intensity of run-off and soil loss. Before the fall rains of 1931 the field has been plowed with a moldboard plow and therefore was able to absorb a great deal of moisture.

Cotton in contoured rows was on the field during the intense rains of 1932 giving the ground but little protection.

Run-off and Soil Loss by Storms, 1932:

Measurements of rainfall, run-off, and soil loss on the terraces comprising this experiment are listed in Table 4 for the seventeen storms which occurred during the year 1932. Values of intensity, amount, and duration for the rain of June 24th fall slightly under those for the rain of May 31st, but are very similar. The rain of June 24th, however, fell on saturated soil, whereas the rain of May 31st fell on dry soil. This caused much greater intensities of run-off, percentages of rainfall appearing as run-off, and soil loss for the rain of June 24th. (See Figure 15 for a graphical record of rainfall and run-off for the rain of June 24th). It is interesting to note that for either of the above mentioned rains the soil loss in tons per acre is practically equal to the total for the year 1931.

The Great Institute of Soil Science and Research in Moscow

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TABLE No. 4

Terraces 3-C to 6-C With Different Grades
Measurements of Rainfall, Run-off, and Soil Loss For Principal Storms During the Year 1932
Red Plains Soil Erosion Experiment Station Near Guthrie, Oklahoma

Date Of	Average Rates of Rainfall					Total Rainfall: For Storm Period	Maximum Rates Of				Run-off:				Total Run-off In Per Cent of Total Rainfall				Soil Loss In Tons Per Acre:				Remarks
	5	10	15	20	30		3-C	4-C	5-C		6-C				3-C	4-C	5-C	6-C	3-C	4-C	5-C	6-C	
	Min.	Min.	Min.	Min.	Min.		Sec. Feet In/Hr.	Sec. Feet In/Hr.	Sec. Feet In/Hr.		Sec. Feet In/Hr.												
January 4	0.48	0.48	0.44	0.39	0.34	2.35	0.56	0.19	0.71	0.25	a	a	a	a	22.6	21.7	a	a	0.21	0.25	a	a	Cowpeas were plowed
" 15	0.36	0.30	0.28	0.27	0.28	0.74	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	under for green
" 21	0.72	0.60	0.56	0.51	0.42	1.19	0.77	0.27	0.82	0.29	0.04	0.002	0.10	0.05	61.3	48.0	20.0 ^b	21.8	0.43	0.39	0.09	Trace	manure with tandem
Feb. 10	2.16	1.80	1.40	1.17	0.88	0.50	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	disc, November 10,
May 31	6.00	4.68	4.20	4.35	3.84	2.96	d	d	6.80	2.44	5.41	2.08	1.98	0.95	41.7	46.6	56.4	48.3	3.13	2.28	2.34	1.11	1931. Field was
June 3	0.96	0.84	0.64	0.63	0.52	0.81	0.22	0.08	0.22	0.08	0.18	0.07	0.12	0.06	16.0 ^b	10.0 ^b	29.6	5.0 ^b	0.14	0.06	0.24	0.04	plowed with mold-
" 4	2.28	1.86	1.68	1.44	1.14	1.09	3.53	1.23	3.62	1.30	2.85	1.10	1.23	0.59	69.7	76.0	75.0	88.0	1.35	0.82	0.52	0.39	board plow, February
" 5	1.92	1.68	1.64	1.44	0.98	0.73	2.48	0.86	2.82	1.01	1.57	0.61	0.51	0.25	59.7	59.5	60.5	68.5	0.84	0.42	0.32	0.13	8, 1932. Cotton was
" 23	1.92	1.56	1.44	1.38	1.32	0.90	0.15	0.05	a	a	a	a	a	a	4.1	a	a	a	a	a	a	a	planted in contoured
" 24	4.80	3.84	3.60	3.54	3.24	2.84	7.51	2.62	6.92	2.48	5.28	2.03	2.33	1.12	71.5	75.0	73.0	79.0	4.72	2.49	2.58	1.52	rows, May 6, 1932.
" 26	0.48	0.36	0.32	0.30	0.28	0.83	0.28	0.10	0.25	0.09	0.10	0.04	d	d	36.5 ^b	20.5	32.0	20.0 ^b	0.29	0.09	0.13	Trace	First cultivation on
" 30	1.56	1.02	0.84	0.84	0.72	0.42	1.93	0.67	1.72	0.62	0.99	0.38	0.40	0.19	60.7	59.5	52.8	61.8	0.59	0.21	0.12	0.06	May 31, 1932. Pick-
July 5	4.56	3.72	2.88	2.34	1.64	1.76	9.27	3.22	7.27	2.60	4.70	1.81	1.88	0.91	68.0	67.0	64.0	74.0	2.19	1.40	0.68	0.56	ing of cotton com-
August 16	2.88	2.64	2.24	1.92	1.52	3.76	0.41	0.14	0.41	0.15	0.43	0.16	d	d	12.3	16.4	12.2	10.0 ^b	0.55	0.16	0.11	0.81	pleted on October
October 3	5.64	3.72	2.96	2.40	1.70	1.02	2.24	0.78	2.24	0.80	d	d	0.27	0.13	32.1	37.4	24.2 ^b	13.7	0.21	0.15	0.07	0.02	14, 1932. Winter
" 25	4.56	3.84	2.88	2.25	1.52	2.14	0.33	0.11	0.25	0.09	0.11	0.04	a	a	3.8 ^b	4.0 ^b	3.8 ^b	a	0.04	0.01	0.01	a	wheat drilled bet-
Dec. 23	0.72	0.60	0.44	0.42	0.38	2.78	0.33	0.11	0.35	0.12	0.18	0.07	0.18	0.09	25.0 ^b	25.0 ^b	25.0 ^b	25.0 ^b	0.17	0.03	0.06	0.02	ween cotton rows on
	Terrace	Land Slope	Vertical Spacing	Length	Grade																		October 13, 1932.
	3-C	4.33	3.51	1500	6" per 100'																		
	4-C	4.41	3.47	1500	4" per 100'																		
	5-C	4.72	3.43	1500	2" per 100'																		
	6-C	5.51	3.27	1500	Level																		
Note:																							
a. = No run-off or no soil loss																							
b. = Total run-off estimated																							
d. = No record due to instrument failure																							

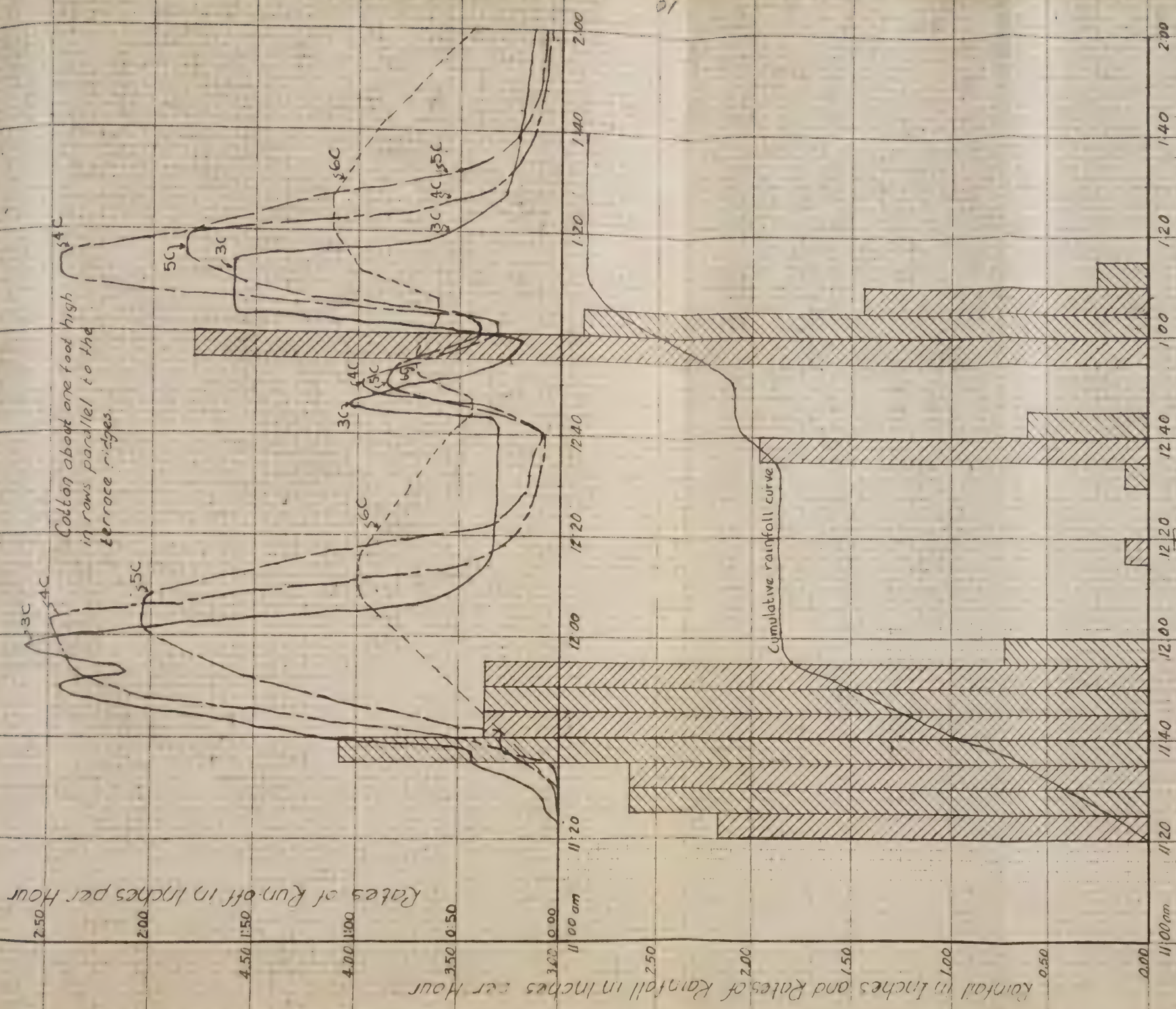


Figure 15 - Cumulative rainfall and rates of runoff of rainfall and run-off for terraces 1500 feet long with vertical spacings of approximately 3.5 feet and grades as follow:- 3C = 6" per 100', 4C = 4" per 100', 5C = 2" per 100', and 6C = level. Rain of June 24, 1932.

Hydrograph records of rainfall and run-off for the rain of October 3rd are shown in Figure 16. This rain was very intense and brief, and fell on dry soil.

Comparison of the various rains for the year 1932 substantiates the following trends outlined in 1931.

1. For similar rains the intensity and run-off percentage increase with the degree of saturation of the soil prior to the rain.

2. Per cent rainfall appearing as run-off decreases as the grade of the terrace is decreased, but the variation is small.

3. Intensity of run-off decreases as the grade of the terrace is decreased.

4. Soil loss per acre decreases as the grade of the terrace is reduced.

Crop Yields:

A crop history of the field for the year 1932 is given in Table 4 and crop yields for the years 1931 and 1932 in Tables 13 and 14. The yield records for both years show minimum yields for Terraces 3-C and 6-C with the maximum and minimum grades of the experiment. The low yield from 3-C is probably caused by the scouring effect of the high velocities of flow on the 6 inches per 100 feet grade while the low yield from Terrace 6-C is believed to be due to the ponds caused by the small deltas formed in the terrace channel. These ponds remain for sufficient

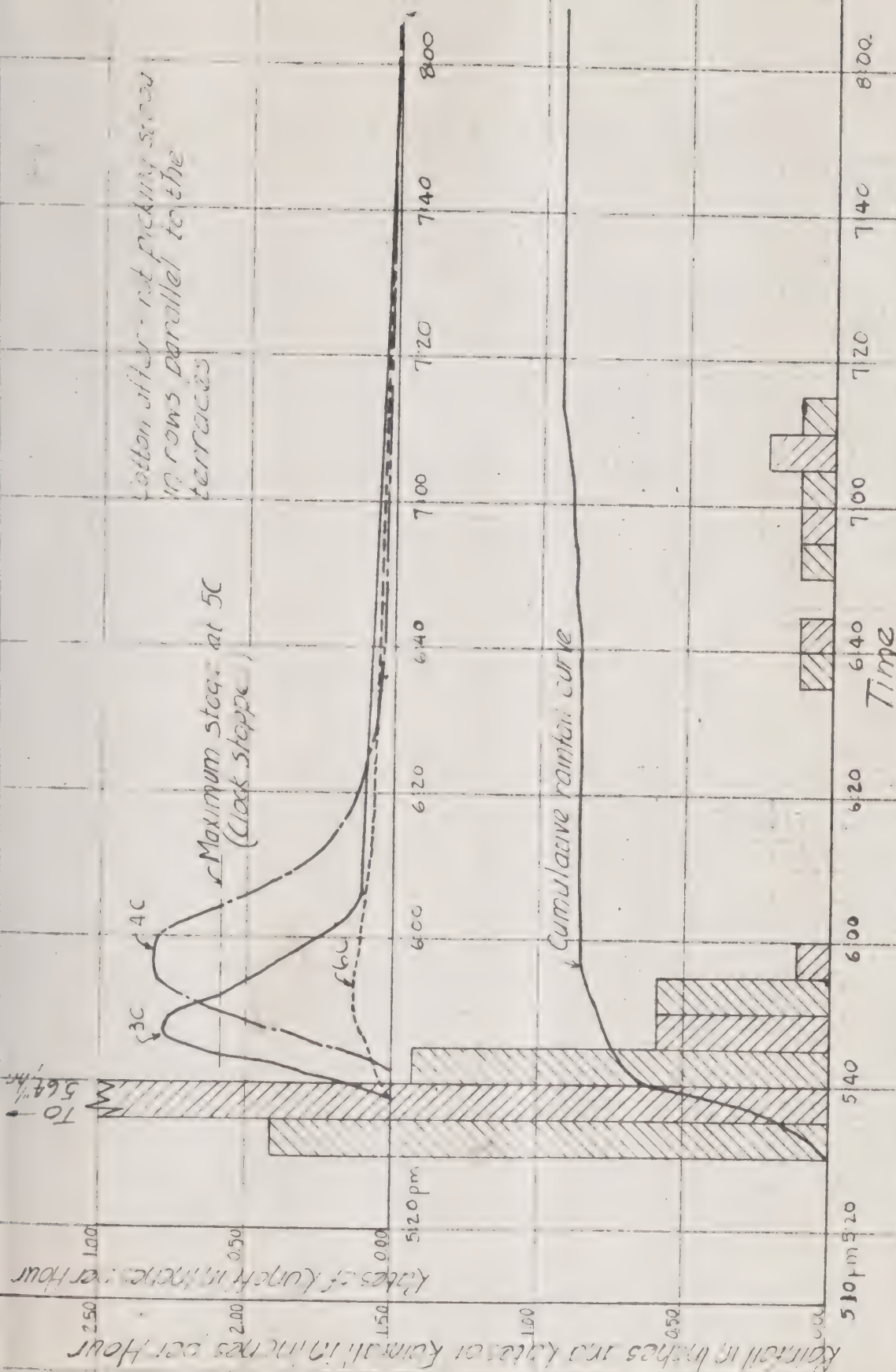


Figure 1b - Cumulative rainfall and rates of rainfall and runoff for terraces 1500 feet long with vertical spacings of approximately 3.5 feet and grades as follows: 3C = 6" per 100', 4C = 4" per 100', 5C = 2" per 100', and 6C = level. Rain of Oct. 3, 1937.

time to drown part of the crop.

Oat yields for the year 1931 were not determined separately by field measurement for the terrace ridge, channel, and interval but were estimated on the basis of narrow strips harvested perpendicular to the contour by the Bureau of Chemistry and Soils. This estimate indicated a slightly higher yield for the interval than for the disturbed area. For the cotton crop harvested in 1932, each unit of ridge, channel and interval was harvested separately. The average of all four disturbed areas, consisting in each case of the terrace ridge and channel was 684.17 pounds of seed cotton per acre and the average of the total area was 583.07 pounds of seed cotton per acre. The average of the per acre yields of the graded terrace channels was 582.36 pounds of seed cotton as compared with 343.02 pounds of seed cotton per acre in the channel of the level terrace.

Conclusions:

Data secured during the year 1932 substantiates all claims made in 1931 and outlines some new trends. All trends so far established by this experiment are outlined below:

1. The per cent of the rainfall appearing as run-off decreases to a small extent with the grade of the terrace.
2. The intensity of run-off decreases decidedly with decreased grade of terrace.
3. Yearly soil loss per acre is about one fourth as much on the level terrace as on the terrace of six inch grade per 100 feet.

time to grown part of the crop.

One point in the year 1931 was not determined separately by field measurement for the various ridges, channels, and intervals but was estimated on the basis of ratios which indicated proportionality to the distance from the bottom of channels and ridges. This estimate indicated a slight increase in the intensity of the rainfall during the interval from the bottom of the ridges to the bottom of the channels. The average of all four intervals was, consisting in each case of the bottom ridge and channel was 234.17 pounds of seed cotton per acre and the average of the total area was 221.77 pounds of seed cotton per acre. The average of the two areas of the bottom ridge and channel was 234.17 pounds of seed cotton per acre and the average of the total area was 221.77 pounds of seed cotton per acre. The average of each ridge and channel was 234.17 pounds of seed cotton per acre in the channel of the level terrace.

General

This record during the year 1931 represents all the data in 1931 and contains some new data. All points on the terrace are by this experiment are outlined below:

1. The per cent of the rainfall appearing as run-off decreases as a small extent of the terrace.
 2. The intensity of run-off decreases decidedly with decreased grade of terrace.
 3. Yearly soil loss per acre is about one fourth as much on the level terrace as on the bottom of the level terrace.
- 100 feet.

4. The terraces with four and six inch grades appear to retain the desired grade in excellent manner so long as the outlet is protected from scouring, while the two inch and level grades are subject to irregularities produced by channel deltas.

5. Crop yield is lowered on the terrace with six inch grade by securing and is lowered on the level terrace by drowning.

In this experiment, these terraces are all approximately one half mile in length and have an average vertical interval of about four feet.

Terraces 1-6 and 2-6 extend across previously cultivated but not badly eroded

land. The other three terraces are located on a severely eroded and gullied

land. Dimensions of all these terraces are listed in Table 5. All are

equipped with Parshall measuring flumes and Benett silt sampling device, with

exception of 4-6, which has only a Parshall measuring flume.

Percentages of rainfall appearing as run-off and soil losses

per acre from these terraces for crop seasons and the total year are

given in Table 13, for the year 1931, and Table 14, for the year 1932.

For the year 1931, terrace 1-6 lost 23.6 per cent of the

rainfall as run-off, terrace 2-6 lost 25.9 per cent and terrace 3-6 lost 24.1

per cent. Records were not secured for terraces 2-6 and 4-6. During 1932

terrace 1-6 lost 17.6 per cent of the rainfall, terrace 2-6 lost 24.6 per

cent, terrace 3-6 lost 23.1 per cent, and terrace 4-6 lost 23.7 per cent of

the rainfall. For both years the runoff on terrace 2-6 with 0" to 4"/100

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For the year 1961, services 1-3 cost \$1.8 per cent of the

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TABLE No. 5

Long Terraces 1-C, 2-C, 2-B, 3-B, and 4-B, With Different Grades, on Virgin and Eroded Land
Measurements of Rainfall, Run-off, and Soil Loss For Principal Storms During the Year 1932
Red Plains Soil Erosion Experiment Station Near Guthrie, Oklahoma

Station Near Guthrie, Oklahoma																										
Average Rates of Rainfall					Total Rainfall:	Maximum Rates of Run-off										Total Run-off In Per Cent				Soil Loss In Tons Per Acre:				Remarks (Crops, Soil, Etc.)		
Date Of	5	10	15	20	30	For Storm	2-C	1-C	2-B	3-B	4-B	2-C	1-C	2-B	3-B	4-B	2-C	1-C	2-B	3-B						
Storm	Min.	Min.	Min.	Min.	Min.	Period	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.						
							Feet	In/Hr.	Feet	In/Hr.	Feet	In/Hr.	Feet	In/Hr.	Feet	In/Hr.										
January 4:	0.48	0.48	0.44	0.39	0.34	2.35	0.46	0.10	0.66	0.11	1.50	0.25	1.37	0.24	d	d	11.5	9.5	37.4	41.8	d	e	0.07	0.14	0.19	A cover crop of winter wheat was planted between the rows of cotton stalks in September 1931. The field remained with this cover until April 10, 1932 when it was plowed with a moldboard plow. The whole area was tandem disced and planted to corn on April 25, 1932. Beginning May 10, 1932 the corn was cultivated every two weeks until June 17, 1932. Cowpeas were planted between the corn rows July 26th. Husking of corn was completed August 22, 1932. Corn stalks were plowed under with moldboard plow, October 20, 1932.
" 15:	0.36	0.30	0.28	0.27	0.23	0.74	a	a	a	a	0.41	0.07	0.29	0.05	d	d	a	10.0 ^b	23.5	11.1	d	e	0.01	0.04	0.02	
" 21:	0.72	0.60	0.56	0.51	0.42	1.19	0.77	0.17	1.11	0.18	2.16	0.36	1.79	0.31	d	d	36.1	32.5	57.3	59.0	d	e	0.17	0.29	0.32	
Feb. 10:	2.16	1.80	1.40	1.17	0.88	0.50	0.08	0.02	0.10	0.02	0.37	0.06	1.05	0.18	0.37	0.06	1.3	1.5	8.8	12.8	8.2	e	a	0.03	0.04	
May 31:	6.00	4.68	4.20	4.35	3.84	2.96	8.00	1.81	8.00 ^c	1.29 ^c	11.87 ^c	1.95 ^c	12.01	2.12	8.00 ^c	1.41 ^c	36.0	32.2	37.7	46.1	44.4	1.71	1.27	1.79	2.02	
June 3:	0.96	0.84	0.64	0.63	0.52	0.81	0.15	0.03	0.22	0.03	0.71	0.12	0.77	0.13	0.51	0.09	2.6	2.0 ^b	21.1	27.2	38.7	0.01	0.04	0.14	0.26	
" 4:	2.28	1.86	1.68	1.44	1.14	1.09	3.17	0.72	4.70	0.76	6.92 ^c	1.14 ^c	6.11	1.07	4.60	0.81	40.8	56.7	69.3	67.4	78.6	0.41	0.71	1.44	0.88	
" 5:	1.92	1.68	1.64	1.44	0.98	0.73	2.57	0.58	2.73	0.44	3.17 ^c	0.52 ^c	4.60	0.80	2.57	0.45	39.8	32.0	37.0	45.6	52.8	0.21	0.31	0.39	0.37	
" 23:	1.92	1.56	1.44	1.38	1.32	0.90	a	a	a	a	1.37	0.23	0.37	0.06	a	a	a	a	11.0	6.0	a	a	a	0.13	0.09	
" 24:	4.80	3.84	3.60	3.54	3.24	2.84	8.88	2.01	13.18	2.12	14.85	2.45	14.69	2.57	10.61	1.87	60.0	62.0	75.4	67.0	74.6	2.29	2.71	3.31	2.74	
" 26:	0.48	0.36	0.32	0.30	0.28	0.83	0.07	0.02	0.33	0.05	0.88	0.14	0.71	0.12	0.77	0.13	3.4	16.4	36.7	31.6	42.3	0.05	0.09	0.26	0.23	
" 30:	1.56	1.02	0.84	0.84	0.72	0.42	1.57	0.35	1.79	0.29	3.44	0.57	3.35	0.58	1.93	0.34	26.5	39.2	64.5	55.2	71.2	0.14	0.16	0.27	0.28	
July 5:	4.56	3.72	2.88	2.34	1.64	1.76	7.27	1.64	10.61	1.71	12.42	2.05	12.20	2.14	8.50	1.50	45.2	51.7	62.0	58.0	65.0 ^b	0.70	0.68	1.41	1.87	
August 16:	2.88	2.64	2.24	1.92	1.52	3.76	2.09	0.47	2.48	0.40	6.80	1.12	6.92	1.21	3.17	0.56	20.0 ^b	20.6	34.8	44.3	36.5	0.29	0.29	0.44	0.78	
October 3:	5.64	3.72	2.96	2.40	1.70	1.02	d	d	1.50	0.24	6.68 ^c	1.10 ^c	6.22	1.09	1.18	0.21	20.0 ^b	24.2	48.1	46.3	13.7	0.08	0.07	0.15	0.24	
" 25:	4.56	3.84	2.88	2.25	1.52	2.14	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	
Dec. 23:	0.72	0.60	0.44	0.42	0.38	2.78	0.35	0.08	0.29	0.05	0.57	0.09	0.58	0.10	0.34	0.06	10.0 ^b	10.0 ^b	15.0 ^b	15.0 ^b	15.0 ^b	0.05	0.07	0.09	0.23	
	Terrace	Land Slope	Vertical Spacing	Grade	Length																					
	2-C	3.66	2.93	0" to 5" per 100'	2525																					
	1-C	3.54	3.91	0" to 4" per 100'	2350																					
	2-B	2.79	3.99	0" to 4" per 100'	2536																					
	3-B	3.70	3.45	0" to 6" per 100'	2856																					
	4-B	4.21	3.98	3" per 100'	2885																					

grade, on badly eroded land was slightly less than twice that occurring on similar terrace 1-C on virgin land. During 1932, terrace 3-B with 0" to 6"/100' grade, on eroded land lost 1.5 times as much water as similar terrace 2-C on virgin land. The increase in per cent run-off for the year 1932 as compared to the year 1931 is due largely to the greater intensity and frequency of storms. On both the virgin and eroded land the terraces with variable grade from 0" to 6"/100' lost about three per cent more of the year's rainfall for 1932 than was true of the terraces with 0" to 4"/100' grade.

Study of soil loss totals shows that for the year 1931 the soil loss in tons per acre for terrace 2-B with a variable grade of 0" to 4"/100' on badly eroded land was 4.67 tons per acre, or 2.4 times the figure of 1.95 tons per acre for similar terrace 1-C on virgin land. For the year 1932, terrace 2-B lost 10.32 tons of soil per acre as compared to 6.65 tons per acre on terrace 1-C. Terrace 2-B lost 1.75 times as much soil as terrace 1-C over the two years of record.

Terrace 3-B, with a variable grade of 0" to 6"/100', lost 5.27 tons of soil per acre in 1931 and 10.56 tons per acre in 1932. These losses are only slightly higher than those on terrace 2-B with 0" to 4"/100' grade. A silt sampling device was not installed on terrace 2-C, which has 0" to 6"/100' grade on virgin land, until late in the spring of 1932 and consequently yearly total losses for 3-B and 2-C cannot be compared. However, for the period May 1st, to October 15th, 1932, the soil loss on terrace 2-C was 5.89 tons per acre as compared with 9.76 tons of soil per acre on terrace 3-B, or 1.65 times as much loss from the eroded land as from the virgin.

Run-off and Soil Loss by Storms, 1932:

Measurements of rainfall, run-off, and soil loss on the terraces comprising this experiment are listed in Table 5, for the seventeen storms which occurred during the year 1932.

The rains of May 31st and June 24th, 1932, had the highest rainfall intensities of the year, and produced the largest soil losses in tons per acre. The rain of June 24th was slightly the lower in all values of intensity and volume, was very similar in manner of occurrence. The rain of May 31st occurred on very dry soil while that of June 24th, occurred on soil nearly saturated; consequently, the intensities of run-off were higher for the later rain. Graphical records of rainfall and run-off are shown in Figure 17, for June 24, 1932.

The difference in amount of soil and ~~water~~ loss between the virgin and eroded land was small for each of these storms. Study of the smaller storms which occurred during the remainder of the year shows the terraces on eroded land consistently losing twice as much soil as those on virgin land. This data indicates that the virgin soil can absorb moisture with sufficient rapidity to prevent excessive run-off during all ordinary rains, but that during rains of excessive intensity and duration this absorption does not act quickly enough to prohibit run-off.

The rain of October 3rd was very intense for a short period, and produced about one third the volume of the major storms. The maximum intensity did not continue for a time equal to the time of concentration and as a result great intensities of run-off were not attained. The difference in run-off and soil loss between virgin and eroded land is

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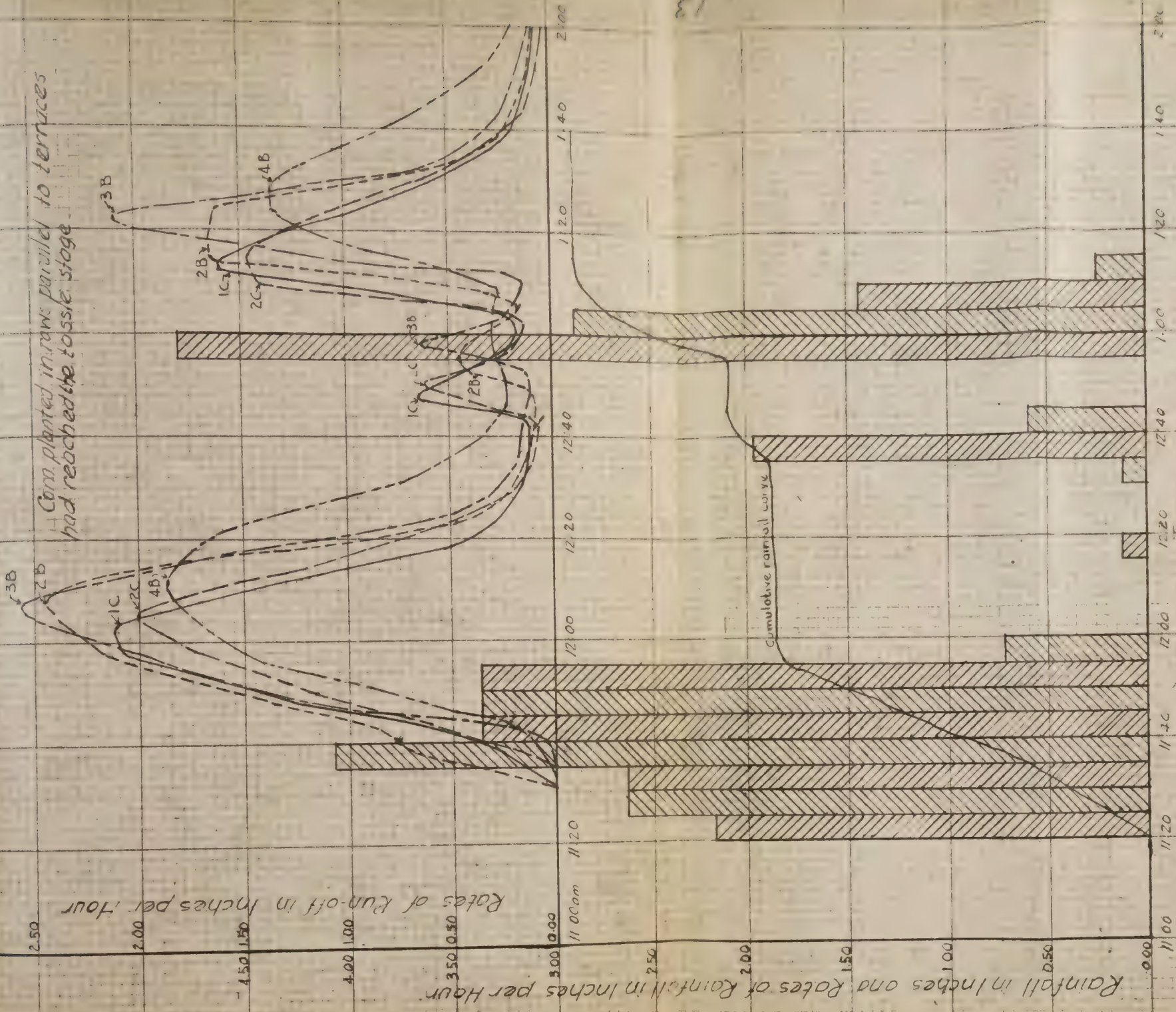


Figure 17 - Cumulative rainfall and rates of rainfall and run-off for terraces one half mile long with average vertical spacings of 3.9 feet. Grades and soil are as follows: 2C = 0" to 6" per 100 ft., 1C = 0" to 4" per 100 ft., both on virgin soil; 2B = 0" to 6" per 100 ft., 3B = 0" to 4" per 100 ft., and 4B = 3" per 100 ft., all three on eroded soil. Rain of June 24, 1932.

Corn planted in rows parallel to terraces had reached the tassel stage

Cumulative rainfall curve

particularly noticeable for this storm. See Figure 18 for hydrographs and rainfall graphs.

Crop Yields:

A crop history of the field for the year 1932 is given ~~xx~~ in Table 5, and crop yields for the years 1931 and 1932 in Tables 13 and 14.

The field produced cotton as a cash crop for the year 1931.

Terrace 1-C on virgin land produced 211 pounds of lint cotton per acre as compared with 161 pounds per acre from terrace 2-B, and 135 pounds per acre from Terrace 3-B, both on eroded land. Corn was raised in 1932, but was seriously damaged by chinch bugs and hot winds. The yields on terraces 2-B and 3-B on eroded land were 6.1 and 6.2 bushels per acre respectively. The virgin land produced 31% more cash crop than the eroded land in 1931, and about 150% more in 1932.

During 1931 the average yield of seed cotton per acre on the area composed of the terrace ridge and channel, which was distributed by the terracing operation, for terraces 2-B, 3-B and 4-B, was 537 pounds per acre and the average for the total area was 555 pounds per acre. On terraces 1-C and 2-C the disturbed area yield was 695 pounds per acre and the yield on the total area was 725 pounds per acre. For 1932, the average yield of corn on the disturbed areas of terraces 2-B, 3-B, and 4-B, was 8.57 bushels per acre, and the yield of the total area traversed by the three terraces was 8.05 bushels per acre. The yield of the disturbed areas of terraces 1-C and 2-C was 18.69 bushels per acre for 1932, and the yield of the total area of these terraces was 16.0 bushels per acre. This data indicates that for 1931, the area not disturbed by terracing had but slight advantage over

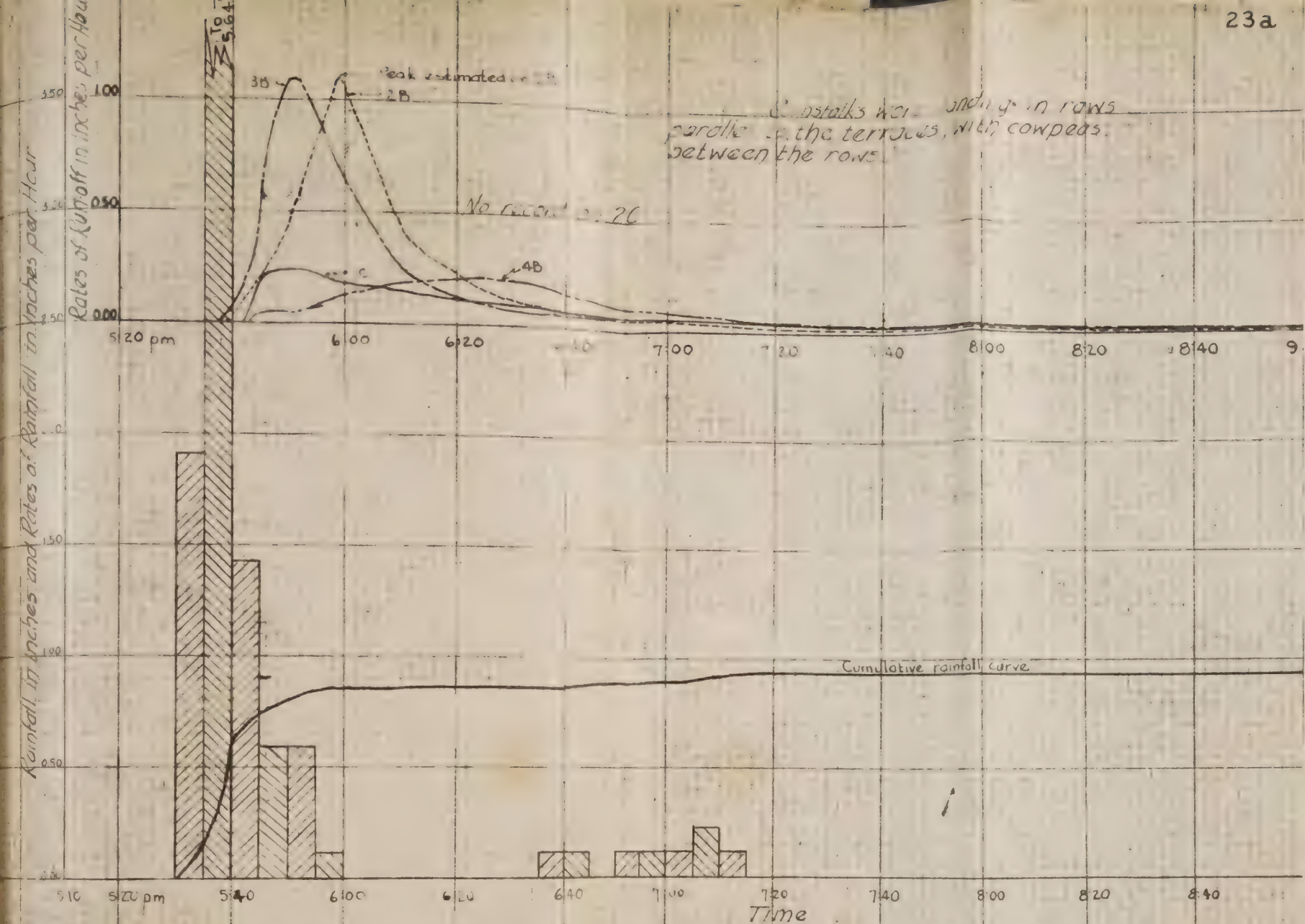


Figure 18 - Cumulative rainfall and rates of rainfall and run-off for terraces one-half mile long, with average vertical spacing of 3.9 feet. Grades and soil are as follows: 2C = 0" to 6" per 100 ft., 3C = 6" to 4" per 100 ft., both on virgin soil; 2B = 0" to 6" per 100 ft., 3B = 0" to 4" per 100 ft., and 4B = 3" per 100 ft., all on eroded soil. Rain, of October 3, 1932.

the disturbed area, and in 1932, the disturbed areas of channel and ridge were more productive. This increase may be due to the washing of good soil from the interval or area not disturbed into the terrace channel where it is held and becomes productive. The data seems to indicate that after one or two years service, there is no loss of productivity as a result of soil disturbance by the terracing operation.

Conclusions:

Data secured to date has outlined the following trends which, however, are not yet considered as definite conclusions:

1. Run-off in per cent of yearly rainfall is about twice as large from terraces located on the severely eroded land contained in this experiment as from the terraces on new land.
2. Yearly soil loss from the terraces on eroded land is approximately twice that from the terraces on new land.
3. During severe storms the absorption capacity of the new soil is overtaxed and the variation between soil loss and run-off on eroded and virgin land is not equal to the yearly average. For lesser storms, the new soil is able to absorb the moisture at a rapid rate and the variation between eroded and virgin land often exceeds the yearly average.
4. Terraces of one half mile length create excessive discharge and consequently extreme depths of flow in the lower sections of the terrace channel. As a result terraces must at all times be maintained to heights of about 18 inches for the

lower 500 feet of length.

5. Crop yields from the terraces located on the virgin land of this experiment were from 31 to 150 per cent higher than those from the terraces on eroded land.

6. Reduction of crop productivity on the soil disturbed by the terracing operation practically disappears after the first two or three years of service for the terraces.

virgin soil, compare the latest for this experiment. The average yield of corn above the terraces is 1.1, 2.4, and 2.5 per cent for terraces 1-2, 3-4, and 5-6, respectively. A record of crops raised and marketed was listed in the following table:

CROPS RAISED AND MARKETED									
Terrace No. 1-2									
1938: Corn	5.6	1	2.5	1	1939: Corn	1.1	1	1940: Corn	2.4
1938: Oats	12.7	1	12.7	1	1939: Oats	12.7	1	1940: Oats	12.7
1938: Beans	20.6	1	20.6	1	1939: Beans	20.6	1	1940: Beans	20.6
1938: Corn	11.0	1	11.0	1	1939: Corn	11.0	1	1940: Corn	11.0

Source: Rebuilding was done after hurricane in 1934. Data for 1938-1940.

lower 250 feet of section.

B. Drop yields from the reservoir located on the right

bank of this reservoir were from 81 to 180 per cent above the

average from the reservoir on the left bank.

C. Reduction of crop productivity on the soil disturbed

by the reservoir on the right bank was about 10 per cent

for the first three years of service for the reservoir.

EXPERIMENT No. 4

Level Terraces With Closed Ends

This experiment yields information concerning the design of level terraces in which the ends are closed and all the rainwater retained. The effect upon crop yield of conserving all the rainfall, and the extent of injury to crops by water standing in terrace channels is studied in relation to these terraces.

Terraces 1-F, 2-F, 3-F, located almost entirely upon virgin soil, comprise the layout for this experiment. Terraces 1-F and 2-F encircle the hilltop at the center of the farm and Terrace 3-F is located at north end of the central ridge. The average slope of land above the terraces is 1.1, 3.3, and 1.6 per cent for Terraces 1-F, 2-F and 3-F, respectively. A record of crops planted and resulting yields is listed in the following table:

CROP YIELDS		TERRACES		1-F	2-F	3-F	
Terrace	1-F	2-F	3-F				
Division	Normal	Subsoiled	Normal	Subsoiled	Normal	Remarks	
Year: Crop	Per Acre	Per Acre	Per Acre	Per Acre	Per Acre		
1929: Cotton	83.4		70.8		143.0	lbs. of lint	
						cotton	
1930: Oats	17.2	16.5	17.2	16.5	31.0	bushels of	
						oats	
1931: Cotton	232.8	214.8	163.8	189.3	206.5	lbs. of lint	
						cotton	
1932: Corn	11.0	9.5	4.5	6.9	Killed	Bushels of	
					by	corn	
					Chinch		
					Bugs		
Note: Subsoiling was done after harvesting cotton in 1929, and before planting corn in 1932.							

During the spring of 1929, water stood above these terraces

EXPERIMENT No. 4

Tests Between 1931 and 1932

This experiment was conducted in 1931 and 1932. The object of the experiment was to determine the effect of the amount of water applied to the cotton crop upon the yield of the crop. The experiment was conducted in a field of cotton near the station. The soil was a heavy loam. The water was applied by means of a hose. The amount of water applied was 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100. The results of the experiment are given in the following table:

YIELD		TREATMENTS		1931		1932		1933	
Lbs. of lint		Lbs. of seed		Lbs. of lint		Lbs. of seed		Lbs. of lint	
0		0		0		0		0	
1		1		1		1		1	
2		2		2		2		2	
3		3		3		3		3	
4		4		4		4		4	
5		5		5		5		5	
6		6		6		6		6	
7		7		7		7		7	
8		8		8		8		8	
9		9		9		9		9	
10		10		10		10		10	
11		11		11		11		11	
12		12		12		12		12	
13		13		13		13		13	
14		14		14		14		14	
15		15		15		15		15	
16		16		16		16		16	
17		17		17		17		17	
18		18		18		18		18	
19		19		19		19		19	
20		20		20		20		20	
21		21		21		21		21	
22		22		22		22		22	
23		23		23		23		23	
24		24		24		24		24	
25		25		25		25		25	
26		26		26		26		26	
27		27		27		27		27	
28		28		28		28		28	
29		29		29		29		29	
30		30		30		30		30	
31		31		31		31		31	
32		32		32		32		32	
33		33		33		33		33	
34		34		34		34		34	
35		35		35		35		35	
36		36		36		36		36	
37		37		37		37		37	
38		38		38		38		38	
39		39		39		39		39	
40		40		40		40		40	
41		41		41		41		41	
42		42		42		42		42	
43		43		43		43		43	
44		44		44		44		44	
45		45		45		45		45	
46		46		46		46		46	
47		47		47		47		47	
48		48		48		48		48	
49		49		49		49		49	
50		50		50		50		50	
51		51		51		51		51	
52		52		52		52		52	
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56		56		56		56		56	
57		57		57		57		57	
58		58		58		58		58	
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67		67		67		67		67	
68		68		68		68		68	
69		69		69		69		69	
70		70		70		70		70	
71		71		71		71		71	
72		72		72		72		72	
73		73		73		73		73	
74		74		74		74		74	
75		75		75		75		75	
76		76		76		76		76	
77		77		77		77		77	
78		78		78		78		78	
79		79		79		79		79	
80		80		80		80		80	
81		81		81		81		81	
82		82		82		82		82	
83		83		83		83		83	
84		84		84		84		84	
85		85		85		85		85	
86		86		86		86		86	
87		87		87		87		87	
88		88		88		88		88	

for several days after a heavy rain, damaging the crop in the terrace channel and causing a delay in tilling the land and planting the crop. In the spring and early summer of 1930 a large amount of rainfall occurred and as a result water stood in the channels of the terraces continuously for over a month, drowning practically all of the oats in the channel.

For the year 1931 the spring rainfall was below normal.

However, water stood in the channels from sixteen to twenty-one days. This period occurred just before cotton planting time and neither delayed planting the crop nor subjected the crop to drowning at any time. Even with such an ideal season as this to provide for the conservation of moisture, a comparison with adjoining graded Terrace 1-C on virgin land shows a yield of 211 pounds of lint cotton per acre as contrasted to 200 pounds per acre for the weighted average terraces of 1-F, 2-F, and 3-F. This indicates that on this particular soil the storage of water by closed level terraces is not an important factor in determining an increased crop yield.

As a result of the series of intense rains which occurred after May 31, 1932 the channels of Terraces 1-F, 2-F and 3-F, were filled with water practically continuously until the middle of July. This resulted in the complete loss of all crop in the terrace channel as shown in the following table:

:	:	:	:	:	:	:	:
:	TERRACES	1-F	2-F	3-F	-	Year	1932
:	Corn Yields on Terrace Channel, Ridge, and Interval						
:	Terrace :	1-F	:	2-F	:	3-F	:
:	Division:	Normal	:	Subsoiled	:	Normal	:
:	:	:	:	:	:	:	:
:	Ridge :	15.1	:	14.1	:	7.5	:
:	:	:	:	:	:	:	:
:	Channel :	0.9	:	0.0	:	0.4	:
:	Interval:	11.4	:	9.6	:	3.5	:
:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:

Killed by chinch bugs

The maximum depth of water in the channels of these terraces following the major rains was so great during the spring of 1932 that the waterline was at times level with the ridge top. Evaporation and percolation lowered this level sufficiently, to prevent overtopping by the next rain. The terraces at this time were maintained to an average height of 1.40 feet for Terrace 2-F and 1.50 feet for Terrace 1-F.

An impervious subsoil underlaid by sandstone is held responsible for the water standing in the terrace channels so long after rains. That portion of the land above Terraces 1-F and 2-F and north of the central dyke, see map Figure 1, was subsoiled to a depth of about 14 inches in the fall of 1929 and again in the spring of 1932. This operation seemed to have no great beneficial effect upon the crop yield during any of the years of record.

In both 1931 and 1932 the water disappeared from the channels of the subsoiled areas from one to five days sooner than from those of the normal area. During certain periods of the year, such as those of planting and harvesting, this short additional time might prove of great value.

Information thus far obtained upon level terraces with no outlet on the eroded soil of the Guthrie farm dictates that they are not satisfactory for the following reasons:

1. Terraces of excessive height or extremely small vertical spacing are required.
2. There is a serious decrease in crop yields due to drowning of crop in the channel and delay in harvesting operations.
3. Wet terrace channels hinder the accomplishment of farm operations at the proper time.

ervation of moisture above these level terraces might tend to increase crop yields as compared with graded terraced land. To date there has been no data to prove this possibility.

It is possible that the first attempt to establish a connection with the Soviet Union was made in 1921, when the Soviet government sent a mission to the Far East. This mission was headed by G. I. Gerasimov, a member of the Soviet government. The mission was to establish relations with the Japanese government and to discuss the possibility of a trade agreement between the two countries. The mission was successful in establishing relations with the Japanese government, but it was not able to reach an agreement on a trade agreement.

The Soviet government continued to try to establish relations with the Japanese government, but it was not until 1924 that a trade agreement was signed between the two countries. This agreement was the first trade agreement between the Soviet Union and a foreign country. It was a significant step in the Soviet Union's foreign policy, as it showed that the Soviet Union was willing to engage in trade with other countries. The agreement was signed on April 16, 1924, in Moscow. It provided for the exchange of goods and services between the two countries, and it also provided for the establishment of a trade commission to oversee the trade between the two countries. The agreement was a success for the Soviet Union, as it was the first time that the Soviet Union had established trade relations with a foreign country. It also showed that the Soviet Union was willing to engage in trade with other countries, which was a significant step in its foreign policy.

EXPERIMENT No. 5

Short Level Terraces With Closed Ends and Long Terraces of Different Lengths With Open Ends

Summary. Information from this experiment indicates the economical

length and spacing of level terraces on eroded land for the particular soil and slope of this experiment. Conclusions are also made in regard to the effect upon crop yields of preventing any run-off by means of the level terrace with closed ends, of permitting some run-off by leaving the end of the level terraces open, and of no artificial obstruction to run-off in the case of land not terraced.

Level Terraces 1-E to 10-E, studied in this experiment vary in length from 250 feet to 650 feet. Starting with Terrace 10-E at the foot of the slope the vertical intervals vary as follows: two feet, two and one half feet, three feet, three and one half feet, four feet, two feet, two and one half feet, two and one half feet, and two feet. The north ends of these terraces are closed and a small embankment is built 100 feet from the north end so that all the rainfall on this strip is retained. This embankment is about three inches lower than the terrace ridge which prevents overtopping of the terrace. The strip of closed end terraces is designated as Plot 14, the untterraced area on the north as Plot 13, and the open end level terraces on the south as Plot 15, (See Map, Figure 1).

Cowpeas were planted in 1929 immediately after the spring rains and as a result did not suffer loss from standing water. On the other hand there was no apparent increase of yield due to increased soil

moisture. Cotton was planted on this land in the spring of 1930 but not all of the terrace channels could be planted because they remained wet during the planting period. This resulted in a low yield of cotton per acre. Cowpeas were again planted for the year 1931 and suffered serious reduction of yield in the channel area due to standing water during the period April 16th to May 12th. Cotton planted in 1932 also produced low yields due to the complete loss of the crop in terrace channels as a result of continuous standing water over the period May 31st to June 15th. Crop yields for Plots, 13, 14 and 15, during the four years of record are listed in the following table:

C R O P Y I E L D S			P L O T S			13.	14.	And	15.
Year	Crop	Plot 13	Plot 14	Plot 15				Remarks:	
1929	cowpeas	462	197					Pounds of shelled peas per acre	
1930	Cotton	107	75	80				Pounds of lint cotton per acre	
1931	cowpeas	655	376	319				Pounds of shelled peas per acre	
1932	Cotton	120	77	91				Pounds of lint cotton per acre	

Detailed records of lint cotton yields for terrace ridge, channel and interval for both Plots 14 and 15, are listed in the following table:

The fourth of water PLOTS 14, AND 15.

Lint Cotton Yield - Terrace Channel, Ridge, and Interval, 1932:							
Plot 14				Plot 15			
Terrace:	Ridge :	Channel :	Interval :	Ridge :	Channel :	Interval :	
2-E :	122 :	0 :	50 :	190 :	107 :	101 :	
3-E :	83 :	0 :	53 :	147 :	39 :	73 :	
4-E :	109 :	0 :	42 :	127 :	53 :	68 :	
5-E :	136 :	5 :	56 :	130 :	28 :	23 :	
6-E :	139 :	0 :	96 :	112 :	19 :	52 :	
7-E :	144 :	0 :	101 :	120 :	34 :	58 :	
8-E :	111 :	0 :	33 :	156 :	67 :	70 :	
9-E :	94 :	31 :	57 :	103 :	78 :	69 :	
10-E :	123 :	16 :	46 :	83 :	57 :	21 :	

Comparison of the yields from the two plots shows similar

yields on ridge and interval but channel yields in Plot 14 were completely destroyed while those in Plot 15 were equal to the interval yields.

Terrace in Plot 15, while level with open ends, suffer con-

siderable loss of yield through the action of water standing in the low places at old gully crossings. The area was severely gullied prior to terracing and as a result the channels are very irregular. Also a large amount of the top soil was used in making the large fills across gullies. The drowning of crops in the channels of terraces in Plots 14 and 15 has kept the per acre yields from these terraces consistently lower than those of Plot 13 with no terraces.

The depth of water in all the level terraces with closed ends became sufficiently great to cause flow over the end embankments and would have readily overtopped the terrace ridge had the embankments not been placed below the level of terrace ridge top.

A group of short level terraces with closed ends were constructed in 1930 on Plot G, and are designated on the map as Terraces 2-G to 5-G inclusive. Field G-1 serves as an unterraced check. The virgin land used in these fields was in woods and brush which was removed just before the terraces were built. Measurements of water standing in the channels, and of crop yields are made to compare with Terraces 2-E to 10-E on severely eroded land.

During the year 1931 water stood in the channels of these terraces for only four days following the period of greatest rainfall and consequently did not damage the crop of cowpeas. The channels were dry enough for the performance of normal farm operations very shortly after the last standing water disappeared. This quick absorption of excess precipitation is marked when compared with the long periods during which water stands in the channels of corresponding terraces on eroded land. The average yield of cowpeas per acre on the closed end terraces was 485 pounds per acre for the year 1931 as compared with 1096 pounds per acre on the unterraced check. This great difference may be due to the fact that the soil ~~disturb~~ disturbed by the terracing operation had not yet had time to regain its productivity. For 1932, the average yield of lint cotton on the terraced plot was 125 pounds per acre as compared with 168 pounds per acre on the plot

The depth of water in all the level terraces was observed

and signed before the date of release of this report.

A series of short level traverses with closed ends were made

1. The first of these is the fact that the
2. second is the fact that the
3. third is the fact that the
4. fourth is the fact that the
5. fifth is the fact that the
6. sixth is the fact that the
7. seventh is the fact that the
8. eighth is the fact that the
9. ninth is the fact that the
10. tenth is the fact that the

During the year 1981 water stood in the channels of these

[illegible]

not terraced, indicating that the terraced land had begun to recover its full productivity while the unterraced area had no doubt lost through erosive action.

The channels of the G terraces would retain standing water for from one to five days following each of the major storms occurring during the spring and summer of 1932, but it appears that the sum of these periods was sufficient to cause some reduction in crop yield in the channel. The following table lists cotton yields for the terrace ridge, channel, and interval for the year 1932:

YIELDS OF LINT COTTON - TERRACES 2-G to 5-G 1932					
Terrace	PLOT G			Plot G-1	
	Ridge	Channel	Interval	Not Terraced	
2 - G	205	51	256	168	
3 - G	189	38	112		
4 - G	152	42	70		
5 - G	202	60	76		

Conclusions from this experiment in regard to closed and terraces on eroded land are quite definitely in line with those from the preceding experiment as follows;

1. Terraces of excessive height or extremely small vertical spacing are required.
2. There is a serious decrease in crop yields due to drowning of crop in the channel and delay in harvesting and planting.

and followed, indicating that the treatment had been applied to the plants. The results of the experiment are given in Table 1.

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TABLE 1				
Results of the experiment				
Treatment	Yield (kg/ha)	Harvesting (days)	Delay (days)	Loss (kg/ha)
Control	100	10	0	0
1	110	11	1	10
2	120	12	2	20
3	130	13	3	30
4	140	14	4	40
5	150	15	5	50

Conclusions from this experiment in regard to closed and

disturbed or eroded land are quite definitely in line with those from the

preceding experiment as follows:

1. There is a serious danger of erosion on eroded land.

2. There is a serious danger of erosion on eroded land.

3. There is a serious danger of erosion on eroded land.

4. There is a serious danger of erosion on eroded land.

5. There is a serious danger of erosion on eroded land.

3. Wet terrace channels hinder the accomplishment of farm operations at the proper time.

Sufficient data has not been obtained from the level terraces on virgin land to serve as a basis for definite conclusion. The following trends are outlined:

1. Absorption takes place at a sufficiently rapid rate to prevent the necessity of unusually high terraces or close spacings.
2. There is some decrease in crop yield due to the standing water during wet years.
3. It may be possible that during years of scant rainfall the conservation of moisture will be of benefit to crops.

1. The first point to be considered is the question of the

2. The second point to be considered is the question of the

3. The third point to be considered is the question of the

4. The fourth point to be considered is the question of the

5. The fifth point to be considered is the question of the

6. The sixth point to be considered is the question of the

7. The seventh point to be considered is the question of the

8. The eighth point to be considered is the question of the

9. The ninth point to be considered is the question of the

10. The tenth point to be considered is the question of the

11. The eleventh point to be considered is the question of the

12. The twelfth point to be considered is the question of the

13. The thirteenth point to be considered is the question of the

14. The fourteenth point to be considered is the question of the

EXPERIMENT No. 6

Terraces With Different Grades on Badly Eroded Land

It is desired to determine the most satisfactory grade for terraces on badly gullied slopes similar to that on which this experiment is located and the time required to fill gullies above terraces with soil deposited by washing and blowing.

Terraces 5-B to 9-B inclusive, located on the badly gullied slope in Field E on the west side of the farm comprises the layout for this experiment. They vary in length from 1,125 to 1,937 feet and the grades are as follows: 5-B and 6-B vary from level to four inches per 100 feet; 7-B from level to three inches; 8-B from level to two inches; 9-B is a level terrace. All of the terraces cross land which is cut by deep gullies and severely damaged by sheet erosion.

Run-off from these terraces was carefully observed after principal storms for the years 1931 and 1932 and the following conclusions drawn:

1. The run-off water from Terrace 8-B with a maximum grade of two inches per 100 feet and from level Terrace 9-B appeared to contain less soil than the run-off from the remaining graded terraces.

2. Run-off from Terraces 8-B and 9-B did not reach maximum depths in the channels equal to those in the other terraces thus indicating lower intensities and less opportunity for erosion.

3. On these same two terraces run-off would continue longer following any storm than was the case on the other terraces in the experiment, thus affording opportunity for greater percolation into the soil.

EXPERIMENT No. 3

THEORY: The channel is a rectangular one.

It is desired to determine the effect of the slope on the velocity of flow. The velocity is to be measured at different points in the channel. The velocity is to be measured at the center of the channel and at the corners. The velocity is to be measured at the top and bottom of the channel.

Apparatus: A rectangular channel, a stopwatch, a ruler, a tape measure, a velocity meter.

Procedure: The channel is to be filled with water. The water is to be allowed to flow from a reservoir. The velocity is to be measured at different points in the channel. The velocity is to be measured at the center of the channel and at the corners. The velocity is to be measured at the top and bottom of the channel. The velocity is to be measured at the top and bottom of the channel.

Results: The velocity is to be measured at different points in the channel.

Conclusions: The velocity is to be measured at different points in the channel.

Notes:

1. The run-off water from terrace 2-B with a maximum grade of 100 inches per 100 feet and from terrace 3-B appeared to contain less silt than the run-off from the retaining graded terraces.

2. Run-off from terrace 2-B and 3-B did not reach water-

and settled in the channels equal to those in the other terraces.

3. On these same two terraces run-off would continue

to the bottom of the channel and the water would be clear.

4. The run-off from terrace 2-B and 3-B did not reach water-

into the soil.

4. There did not appear to be any appreciable difference in damage to crops by run-off water from any of the terraces in this experiment.

5. The period of time following any storm before farm operations could be resumed in the channels was about equal for all the terraces.

Soil borne by wind and run-off water has been deposited in the depressions left at points where the terraces crossed gullies. In the two years which have elapsed since the construction of the terraces this deposition has been sufficient to completely obliterate many of the depressions left by the smaller gullies. The depressions caused by the larger gullies have been filled sufficiently to prevent serious damage to crops by standing water. These soil deposits in many cases are from one to two feet in depth. See Figure 19, for profiles of these terraces as taken in 1929 and early in 1933.

4. There did not appear to be any considerable
disturbance in damage to crops by run-off water from any of
the terraces in this experiment.

5. The period of time following any storm before
large quantities could be resumed in the channels was about
equal for all the terraces.
Still more to the west and south water has been observed to

the terraces left at points where there terraces crossed gullies. In
the two years since water crossed them but no considerable amount of the
this observation has been noticed. It is possible that the amount of the
deposition left by the smaller gullies. The terraces seem to be
larger gullies have been filled with debris. It is possible that the
to some in standing water. There will be some in some cases
are in the fact in fact. The figure 17. The position of these terraces
as taken in 1938 and early in 1939.

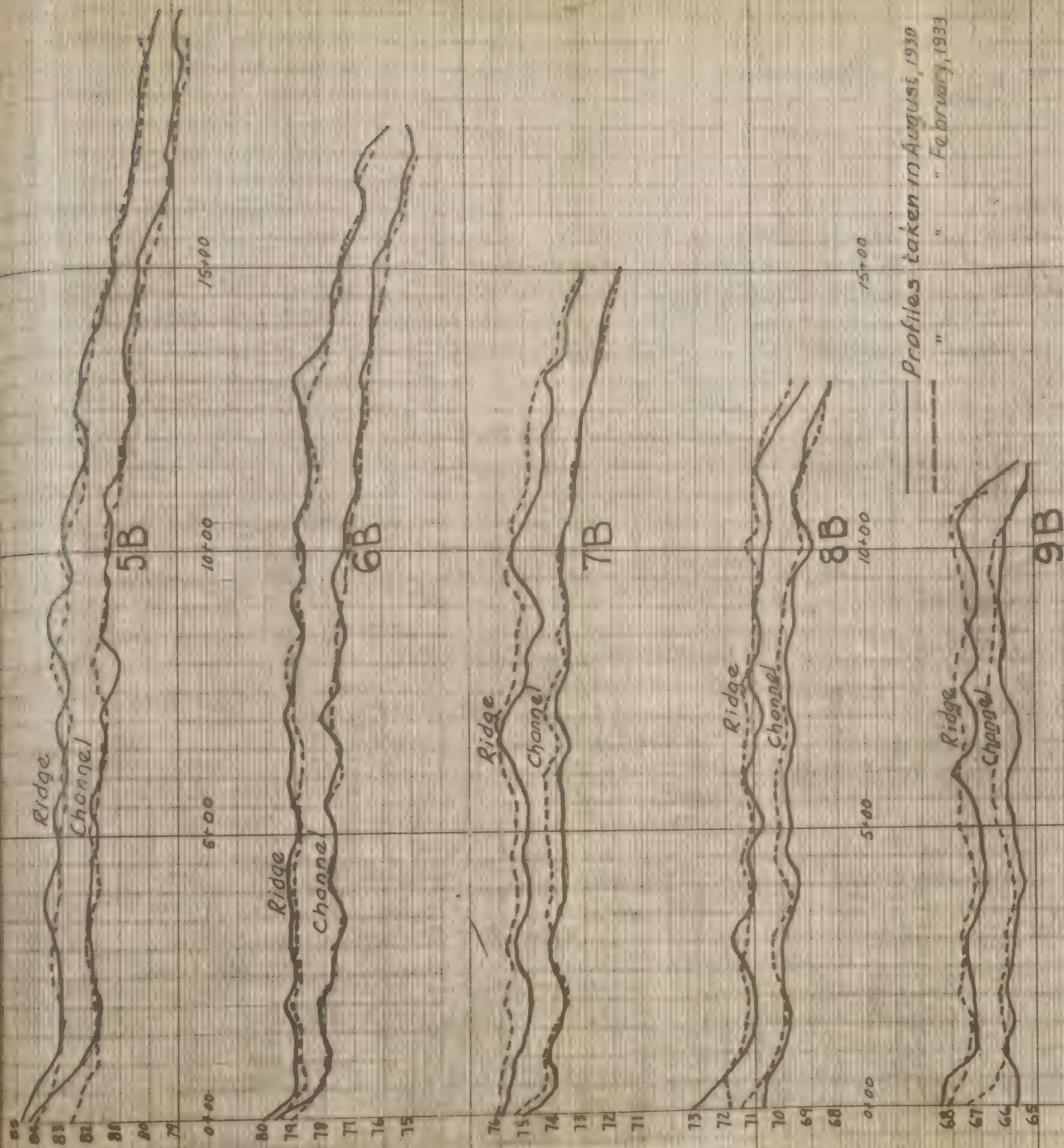


FIGURE - TERRACE PROFILES, FIELD E,
 RED PLAINS SOIL EROSION EXPERIMENT STATION

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EXPERIMENT No. 7

Construction of Terraces - Methods and Cost

It is necessary that information be obtained on the most economical methods, the most satisfactory machines, and the most efficient cross section for use in terrace construction. Data of this type was analyzed in the report for the years 1929 and 1930. A summation of data secured for all terraces built on the Guthrie erosion farm and was analyzed in the report for the years 1929 and 1930. A summation of this data is presented in Table 5.

In order that this information may be expanded to cover all desirable methods, implements, and designs, additional terrace construction work is done from time to time on nearby farms, under the supervision of the Bureau of Agricultural Engineering. Summations of such data secured during the years prior to 1932 are also listed in Table 6.

It has been the practice at the Guthrie Station to try out all new type terracing machines so that their comparative efficiency and cost of operation might be determined. The construction of terraces on the Guthrie station farm during the years 1929 and 1930 was conducted largely with the Martin Ditcher and Corsicana terracer with results as listed in Summary Table No. 6. Work for the years 1931 on outside farms was conducted with the Caterpillar 8 foot blade terracer and with large county road machinery.

Terrace construction work during the year 1932 was devoted entirely to comparisons of the one way Wheatland Disc Plow with 26 inch

EXPERIMENT NO. 7

Investigation of the effect of the amount of water on the rate of reaction.

It is necessary that the amount of water be constant in each trial.

Experimental method: The most satisfactory method is to use a graduated cylinder.

The amount of water used in each trial is measured by the graduated cylinder.

The rate of reaction is determined by measuring the volume of gas evolved in a given time.

The results of the experiment are shown in the following table.

This data is presented in Table 6.

In order that this information may be expanded to cover

all possible methods, the following table is presented.

Experiment was done with the following results.

Experiment of the effect of the amount of water on the rate of reaction.

Each data recorded during the experiment is shown in the following table.

Table 6.

It has been the practice of the Bureau of Standards to

use all new chemical materials as soon as they become available.

The results of the experiment are shown in the following table.

The results of the experiment are shown in the following table.

Large amounts of water are used in the experiment.

It is found that the rate of reaction is directly proportional to the amount of water used.

The results of the experiment are shown in the following table.

Results are shown in the following table.

Results of the experiment are shown in the following table.

Results of the experiment are shown in the following table.

SUMMARY OF TERRACE CONSTRUCTION COSTS
Red Plains Soil Erosion Experiment Station Near Guthrie, Oklahoma

Name of Farm:	Terraces:	Acres	Cost Per Acre			Cost Per Mile			Average			Size of Terrace:	Machinery Used	Description and Condition of Soil		
			Terraced	Grading	Fill	Total	Grading	Fill	Total	Land	Slope				Average Height	Average Width
Guthrie Station	1A to 10A:	11.93	12.44	needed	12.44	101.75	needed	101.75	5.6	1.7	20	Martin Ditcher - John Deere Tractor "15"	Sandy loam soil, newly cleared land, with stumps, rock and roots			
"	2B to 4B:	18.62	3.06	1.98	5.02	36.38	23.30	69.68	3.6	1.3	26	8-foot Corsicana - John Deere Tractor 15	Badly eroded sandy clay soil with few shallow gullies			
"	5B to 9B:	13.98	5.94	8.61	14.55	57.48	83.40	140.88	4.9	1.6	25	8-foot Corsicana - John Deere Tractor 15	Badly eroded sandy clay soil with numerous deep wide gullies			
"	1E to 10E:	9.13	6.03	4.27	10.30	56.56	40.30	96.86	3.9	1.5	20	8-foot Corsicana - John Deere Tractor 15	Badly eroded sandy clay soil with numerous deep gullies			
"	1C to 2C:	7.12	4.49	2.46	6.95	50.17	27.50	77.67	4.2	1.6	27	Martin Ditcher and 8-foot Corsicana - John Deere Tractor "15"	Old cultivated field and pasture with few small gullies			
"	and 1F to 2F:	4.42	7.41	needed	7.41	72.02	needed	72.02	2.7	1.5	27	Martin Ditcher and 8-foot Corsicana - John Deere Tractor "15"	Newly cleared land with stumps and roots, virgin			
"	3C to 6C:	12.99	3.99	2.51	6.50	38.67	24.30	62.97	4.6	1.5	26	Martin Ditcher and 8-foot Corsicana - John Deere Tractor "15"	Old cultivated field & pasture with few gullies, more than half virgin, remainder			
"	1G to 6G:	4.80	5.93	needed	5.93	53.64	needed	53.64	4.3	1.4	22	Martin Ditcher - John Deere Tractor "15"	Newly cleared land with stumps and rocks. (eroded)			
Above costs include Fuel and Repairs but not interest and depreciation on Machinery																
Sutton		4.90	0.54	0.61	1.15	8.67	9.93	18.60	3.0	1.4	26	26-inch one way plow - Caterpillar "15" Tractor	Loose sandy loam, excellent condition for terracing			
Bergman		10.60	0.83	1.13	1.96	18.70	25.50	44.20	3.0	1.3	25	Caterpillar Terracer and 15 Tractor	Sandy loam, good condition.			
Luekenbill		11.50	1.80	1.00	2.80	4.05	2.26	6.31	5.0	1.3	28	Stockland 12-foot blade grader - Caterpillar "60" Tractor	Loose top soil, heavy subsoil, good condition			
Allen		30.00	0.97	0.13	1.10	16.11	2.17	18.28	6.0	1.4	24	" " " "	Soil hard and dry, sand rock exposed in places, gullies			
Egleston		14.00	0.80	needed	0.80	13.01	needed	13.01	3.4	1.2	24	" " " "	Loose sandy soil in excellent condition			
Goosch		81.00	0.76	0.67	1.43	9.47	8.39	17.86	5.4	1.2	24	" " " "	Soil hard and dry, sandy, gullies.			
Burst		55.00	0.52	0.44	0.96	8.63	7.25	15.88	4.5	1.0	23	" " " " and one way plow - Caterpillar "15" Tractor	Soil in fair condition, gullies.			
Faulkner		19.50	0.75	0.16	0.91	13.55	2.89	16.44	3.1	1.5	29	" " " "	Soil in good condition, gullies.			
Allen		2.60	0.68	not	no	9.30	not	no	6.0	1.3	24	26-inch one way plow - Caterpillar "15" Tractor	Badly gullied soil in good condition			
Simpson		57.00	0.81	done	Record.	11.53	done	record	4.0	1.2	27	Caterpillar 8-foot blade grader and "15" Tractor	Condition of soil excellent for terracing although slightly wet, gullied.			
Elliott		11.20	1.25	"	"	11.75	"	"	3.5	1.2	30	Caterpillar "15" Tractor, Caterpillar Terracer, Moline 26-inch one way plow, Rumely Oil Pull Tractor, Case 23-inch one Way Disc Plow	Moist but not wet, ideal for blade machine but too moist for disc.			
Stockland grader and "60" Caterpillar tractor owned by county for which no charge was made and above costs includes only fuel for tractor. Other costs above include fuel and repairs but not interest or depreciation on machinery.																

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and 23 inch discs, and to the Caterpillar Terracer with eight foot blade.

This work was conducted on the Borgman, Faulkner, Allen and Elliott farms, all located conveniently near the Red Plains Soil Erosion Experiment Station.

Detailed cost and construction data from this work is listed in Table 7.

The application of machines which serve routine duties in farm operations to the construction of terraces is a study worthy of much consideration. It is obvious that the first cost, depreciation and upkeep of such machines would not have to be charged entirely to one operation and consequently should be highly economical. The one-way disc plow is used extensively for the preparation of land in the wheat regions of the middle west and appears to offer possibilities for development as an efficient terracing machine. Accordingly several terracing projects were conducted during the years 1931 and 1932 with the Moline 26 inch one-way disc owned by the Guthrie station. It is planned to supplement these studies during the year 1933 with tests of a Case 23 inch one-way disc plow.

Discussion of 1932 Terrace Construction.

The first project for the year was conducted on the Borgman farm on severely eroded and gullied land. Terrace B-1 on this soil in good condition was constructed for \$16.16 per mile, while terraces B-2 and B-3 which passed through a 100 yard deposit of windblown sand on a north facing slope cost \$21.33 and \$17.58 per mile, respectively. The deep and loose sand caused the terracer to bog down and make accurate control of the blade impossible. All terraces constructed averaged 15 to 16 inches high and 25 feet in width. The cost per mile of terrace for all terraces so far

COST OF TERRACE CONSTRUCTION - BORGMAN, FAULKNER, ALLEN AND ELLIOTT FARMS
Work Conducted by Bureau of Agricultural Engineering - Red Plains Soil Erosion Experiment Station.

Engineering - Red Plains Soil Erosion Experiment Station.																			
Terrace:		Machine:	Length:	Size Of Terrace:			Data:		Work Per 100 Feet of Terrace:				Cost of Terrace:		Condition:		Surface:		
of		Height:	Width:	of	Slope:	Vertical:	Linear:	Machine Hours:	Man Hours:	Without Scraper:		of		Soil:		Cover:			
Number:	Used:	Terrace:	in	in	Land	Interval	Feet Of	Terrace	Tractor:	Grader:	Tractor:	Grader:	Per	Per	Per	of	Method of Construction		
:	:	Feet	Feet	Ft/100'	Feet	Per	Per	Per	:	:	:	:	100'	Mile	Acres	:	:		
B O R G M A N F A R M																			
B-1	A	785	1.30	25	3.0	3.5	--	0.34	0.34	0.34	0.34	0.31	16.16	--	Good	None	Both sides only - 12 rounds		
B-2	A	1035	1.30	25	3.0	3.5	--	0.45	0.45	0.45	0.45	0.40	21.38	--	300' Sand	None	Both sides only - 13 rounds		
B-3	A	675	1.30	25	3.0	3.5	--	0.37	0.37	0.37	0.37	0.33	17.58	--	200' Sand	None	Upper side only - 13 rounds		
									Grading:		Fill:		Total:						
									0.47 miles of terrace on) Per Acre		0.83		1.13		1.96				
									10.6 acres at average cost) Per Mile		18.70		25.50		44.20				
F A U L K N E R F A R M																			
F-1	A	900	1.42	30	--	--	257	0.31	0.31	0.31	0.31	0.28	14.73	0.72	Very Good	Wheat	Both sides only - 12 rounds		
F-2	A	1160	1.87	20	2.8	3.5	322	0.44	0.44	0.44	0.44	0.40	20.91	1.27	"	Stubble	Upper side only - 15 rounds		
F-3	A	1740	1.43	30	3.0	3.0	352	0.24	0.24	0.24	0.24	0.22	11.40	0.76	"	and	Upper side - 11 trips - 10 rounds		
									Plow		Plow						Lower side - 9 trips		
F-4	B	1000	1.60	30	3.0	3.0	270	0.26	0.26	0.26	--	0.16	8.24	0.42	"	Weeds	Both sides only - 12 rounds		
F-5	B	900	1.32	34	3.7	3.0	237	0.32	0.32	0.32	--	0.19	10.14	0.45	Some Small	"	Both sides only - 15 rounds		
									Grading:		Fill:		Total:						
									1.08 miles of terrace on) Per Acre		0.75		0.91						
									19.5 acres at average cost) Per Mile		13.55		2.39		16.44				
A L L E N F A R M																			
A-1	B	450	1.37	24	6.0	--	--	0.32	0.32	0.32	--	0.19	10.14	--	Severely	Eroded			
A-2	B	550	1.30	24	6.0	4.0	--	0.29	0.29	0.29	--	0.17	9.19	--	With Gul-	Weeds	Both sides only - 14 rounds		
									Grading:		Fill:		Total:						
									0.19 miles of terrace on) Per Acre		0.68		not done		0.68		Exposed		
									2.6 acres at average cost) Per Mile		9.30		"		9.30		Rock		
E L L I O T T F A R M																			
E-1A	A	469	1.47	32	10 to 3.7	4' to top	768	0.403	0.405	0.405	0.405	0.364	19.25	2.81	Moist but	Sudan	Both sides equally - 10 rounds		
E-2A	B	772	0.97	34	3.7	3.0	642	0.421	--	0.421	--	0.253	13.37	1.63	not wet	Stubble	Upper side only - 4 rounds		
E-3A	A	880	1.43	30	5.0	4.0	567	0.341	0.341	0.341	0.341	0.307	16.22	1.74	Ideal for	"	Both sides equally - 18 rounds		
									blade						Both sides equally - 10 rounds				
E-1B	B	575	1.31	27	10 to 3.8	3.0	411	0.290	--	0.290	--	0.174	9.20	0.71	machine	Kaffir	Upper side only - 4 rounds		
E-2B	A	1064	1.41	32	3.8	3.0	682	0.282	0.282	0.282	0.282	0.254	13.42	1.74	but al-	Stubble	Both sides equally - 12 1/2 rounds		
									most too						Upper side only - 3 1/2 rounds				
E-3B	D	1400	0.99	30	3.1	3.5	460	0.250	--	0.250	--	0.150	7.92	0.69	moist for	"	Both sides equally - 12 1/2 rounds		
E-4B	C	1115	0.97	28	4.0	3.0	598	0.269	--	0.269	--	0.163	8.61	0.97	one way	"	Both sides equally - 9 1/2 rounds		
									Grading:		Fill:		Total:						
									1.19 miles of terrace on) Per Acre		1.25		not done		1.25				
									11.2 acres at average cost) Per Mile		11.75		"		11.75				
Machine Notations :																			
A = Caterpillar 15 Tractor and Caterpillar Terracer																			
B = Caterpillar 15 Tractor and Moline 26", One Way Disc Plow																			
C = Rumely Oil Pull 25 Horsepower Tractor and Moline 26", One Way Disc Plow																			
D = Rumely Oil Pull 25 Horsepower Tractor and Case 23", One Way Disc Plow																			
														Labor = \$ 0.30 per hour					
														Tractor = 0.30 per hour					
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constructed with Caterpillar terracer has varied from a minimum of \$11.40 per mile to \$21.38 per mile, dependent largely on the type of soil and topography encountered, and the skill of the operators. The size of the terraces was kept uniform as near as possible.

Terraces constructed on the Faulkner farm were the second project for the year. Five terraces with a total length of 1.08 miles were built on 19.5 acres of land at an average cost of \$13.55 per mile for grading and \$2.89 for fill work or a total of \$16.44 per mile. The soil encountered on this farm was a Kirkland fine sandy loam in a dry condition with some Rocky Mountain outwash material in places on the higher knolls. There had been no serious damage by erosion. The topography was of a uniform rolling type, ideal for rapid terrace construction.

Terraces F-1, F-2 and F-3 were constructed with the Caterpillar Terracer drawn by a Caterpillar 15 tractor. Terraces F-4, and F-5 were constructed on the same soil and slope with the Moline 26 inch one-way disc plow and Caterpillar 15 tractor. See Figure 20 for comparative composite cross sections of these terraces. The cost of grading per mile on Terrace F-1, was \$14.73, on Terrace F-2 was \$20.91, and on Terrace F-3 was \$11.40. Similar costs on Terraces F-4 and F-5 were \$8.24 and \$10.14 respectively. Approximately the same number of rounds was required for each machine on similar terraces but the difference in cost was derived from the fact that two men were required to operate the blade terracer and tractor whereas one man could operate the one-way plow and tractor.

AND ALLEN FARMS, CANTON, WISCONSIN

conducted with California between the years of 1914
and 1915, however, largely on the type of soil and
topography considered, and the soil of the region. The size of the
interview was very small and was as possible.

Interview conducted on the subject of the soil
project for the year. The interview was a small amount of 1.50 miles was
held on 12.3 miles of land at an average cost of \$11.00 per mile for
drilling and \$1.00 per mile for a total of \$12.00 per mile. The soil
was considered as this type was a kind of this soil is a dry soil-
then also some heavy material material is given in the light
soils. There had been an average amount of 1.50 miles. The topography
was of a small rolling type, about 1.50 miles long.

Interviews 1-1, 1-2 and 1-3 were conducted with the same
person. Interview 1-1 was a California 12 project. Interview 1-2, and 1-3
were conducted on the same soil and also with the same 12 inch survey
the size and California 12 project. The type of soil was 1.50 miles
possible other sections of these interviews. The type of soil was 1.50 miles
Interview 1-1, was \$11.00, on Interview 1-2 was \$11.00, and on Interview 1-3 was
\$11.00. Similar costs on Interview 1-1 and 1-2 were \$11.00 and \$11.00
respectively. Approximately the same amount of funds was required for
each section on similar sections but the difference in cost was derived
from the fact that the two were required to operate the same interview
and similar sections was not able to operate the same size and project.

Terrace F-1 was built equally from both sides, Terrace F-2 from upper side only, and terrace F-3 was built with eleven trips on the upper side and nine on the lower side for a total of ten rounds. The composite cross sections of these terraces in Figure 20, show a great deal more channel room on the terrace built from the upper side only. The slope of land on all three terraces was 3.0 per cent or less. This data strengthens the conclusions reached in the work of 1929, 1930, and 1930, that terraces may be built more cheaply from the upper side, when the land slope is greater than four per cent. On slopes less than four per cent, more economical results are obtained by building the terrace practically equally from both sides. When using the one-way disc plow, it is necessary to work equally from both sides of terrace since the plow can not be reversed.

The two terraces built on the Allen farm with the 26 inch one-way disc plow brought out the fact that this machine performs satisfactorily on slopes of six per cent and on severely eroded land with rock exposed. The soil was dry and hard. The costs were only \$10.14 and \$9.19 per mile for grading work. Figure 20 shows by composite cross sections that these terraces were of satisfactory section.

The basic aim of the terrace construction work on the Elliott farm was to secure a strict comparison of the 8 foot blade terracer and the 26 inch one-way disc. The soil on Elliott Field A was severely eroded and gulled and was quite moist, though ideal for blade operation. The soil under this condition proved to be too sticky for the discs, causing them to clog full of dirt and thus lose all dirt moving action, (See figure 21). Terraces E-1-A and E-3-A were built with the 8 foot blade machine, in 14 and 13 rounds, and are

Between Y-1 and Y-2 there is a small gap, between Y-2

and Y-3 there is a small gap, and between Y-3 and Y-4 there is a small gap.

Between Y-4 and Y-5 there is a small gap, and between Y-5 and Y-6 there is a small gap.

Between Y-6 and Y-7 there is a small gap, and between Y-7 and Y-8 there is a small gap.

Between Y-8 and Y-9 there is a small gap, and between Y-9 and Y-10 there is a small gap.

Between Y-10 and Y-11 there is a small gap, and between Y-11 and Y-12 there is a small gap.

Between Y-12 and Y-13 there is a small gap, and between Y-13 and Y-14 there is a small gap.

Between Y-14 and Y-15 there is a small gap, and between Y-15 and Y-16 there is a small gap.

Between Y-16 and Y-17 there is a small gap, and between Y-17 and Y-18 there is a small gap.

Between Y-18 and Y-19 there is a small gap, and between Y-19 and Y-20 there is a small gap.

Between Y-20 and Y-21 there is a small gap, and between Y-21 and Y-22 there is a small gap.

Between Y-22 and Y-23 there is a small gap, and between Y-23 and Y-24 there is a small gap.

The two between Y-24 and Y-25 there is a small gap.

Between Y-25 and Y-26 there is a small gap, and between Y-26 and Y-27 there is a small gap.

Between Y-27 and Y-28 there is a small gap, and between Y-28 and Y-29 there is a small gap.

Between Y-29 and Y-30 there is a small gap, and between Y-30 and Y-31 there is a small gap.

Between Y-31 and Y-32 there is a small gap, and between Y-32 and Y-33 there is a small gap.

were of satisfactory section.

The section at the bottom of the section was of the type

There was a small gap between Y-33 and Y-34 there is a small gap.

Between Y-34 and Y-35 there is a small gap, and between Y-35 and Y-36 there is a small gap.

Between Y-36 and Y-37 there is a small gap, and between Y-37 and Y-38 there is a small gap.

Between Y-38 and Y-39 there is a small gap, and between Y-39 and Y-40 there is a small gap.

Between Y-40 and Y-41 there is a small gap, and between Y-41 and Y-42 there is a small gap.

Between Y-42 and Y-43 there is a small gap, and between Y-43 and Y-44 there is a small gap.

and the

of good height and considerable width, growing to the height of 10 feet. This is Figure 20. Terrace B-1-5 is a good example of a good height and considerable width, growing to the height of 10 feet. There were 10 rows made on this terrace and the width of the rows was 10 feet. The width of the rows was 10 feet.

Figure 21: Wheatland one-way disc plow working in moist soil on the Elliott farm. The discs are badly clogged with the sticky earth and are no longer efficient as dirt movers.

Terrace B-1-5 was built in the winter of 1940 and was 10 feet high and 10 feet wide. It was built in 5 weeks with the help of 10 men. The cost was \$2000 per acre. The two terraces were built in the winter of 1940. The two terraces were built in the winter of 1940. The two terraces were built in the winter of 1940.

Figure 21: Wheatland one-way disc plow working in moist soil on the Elliott farm. The discs are badly clogged with the sticky earth and are no longer efficient as dirt movers.

The resulting rows were 10 feet high and 10 feet wide. The resulting rows were 10 feet high and 10 feet wide. The resulting rows were 10 feet high and 10 feet wide. The resulting rows were 10 feet high and 10 feet wide. The resulting rows were 10 feet high and 10 feet wide.

At the time terraces were built in 1940, the weather was very dry. It was suggested that the terraces be built in the winter of 1940.

The first of these is the fact that the...

and secondly, the fact that the...

and thirdly, the fact that the...

and fourthly, the fact that the...

and fifthly, the fact that the...

and sixthly, the fact that the...

and seventhly, the fact that the...

and eighthly, the fact that the...

and ninthly, the fact that the...

and tenthly, the fact that the...

and eleventhly, the fact that the...

and twelfthly, the fact that the...

and thirteenthly, the fact that the...

and fourteenthly, the fact that the...

and fifteenthly, the fact that the...

and sixteenthly, the fact that the...

and seventeenthly, the fact that the...

and eighteenthly, the fact that the...

and nineteenthly, the fact that the...

and twentiethly, the fact that the...

and twenty-firstly, the fact that the...

and twenty-secondly, the fact that the...

and twenty-thirdly, the fact that the...

and twenty-fourthly, the fact that the...

and twenty-fifthly, the fact that the...

and twenty-sixthly, the fact that the...

and twenty-seventhly, the fact that the...

and twenty-eighthly, the fact that the...

and twenty-ninthly, the fact that the...

of good height and substantial section according to the composite cross section in Figure 22. Terrace E-2-A, built with the one-way disc plow, had low height and channel capacity according to the composite section. There were 18 rounds made on this terrace but they were not effective because of the moist dirt clogging the discs.

Terraces E-1-B, E-2-B, and E-3-B, and E-4-B, were located in Elliott Field B, which was not severely eroded. The soil was not as moist as that in Elliott Field A, and did not contain as much sticky clay.

Terrace E-1-B was built in $12\frac{1}{2}$ rounds with the one-way 26 inch disc plow at an average cost of \$9.20 per mile. Terrace E-2-B was built in 9 rounds with the eight foot blade terracer at an average cost of \$13.42 per mile. The two terraces are comparable in soil and cross section (See Figure 22) but E-1-B was shorter with a greater percentage of time loss on turns.

Terrace E-3-B was built in $12\frac{1}{2}$ rounds with a Rumely Oil Pull tractor of 25 horsepower and a Case one-way disc plow using discs 25 inches in diameter. Terrace E-4-B was built in $9\frac{1}{2}$ rounds with the same tractor and the Moline one-way disc plow using 26 inch diameter discs. The resulting cross sections of these terraces are similar (See Figure 22), but are not of satisfactory height or volume. Since these two terraces do not give a good comparison of the efficiency of the 23 and 26 inch discs, it will be necessary to study this subject by more construction during 1933.

At the time terraces were first built with the one-way disc plow, it was suggested that the resulting ridge, being loose, would lose

Vertical Scale; 1 inch = 2 Feet

24

22

20

18

16

14

12

10

8

6

4

2

0

2

4

6

8

10

12

14

16

18

20

42 a

E1A

Built with 8' Blade Terracer, 4 rounds

1.7'

E2A

Built with 26" One way disc plow, 18 rounds

0.9'

E3A

Built with 8' Blade terracer, 13 rounds

1.48'

E1B

Built with 26" One way disc plow, 12½ rounds

1.3'

E2B

Built with 8' Blade terracer, 12½ rounds

1.4'

E3B

Built with 23" One way disc plow, 12½ rounds

0.8'

E4B

Built with 26" One way disc plow, 9½ rounds

1.45'

COMPOSITE CROSS-SECTIONS OF TERRACES BUILT WITH VARIOUS MACHINES ON THE ELLIOTT FARM NEAR GUTHRIE, OKLAHOMA

most of its effective height by settling. Surveys were made to determine the change in height of the Faulkner terraces after they had stood for six months, with results as shown in the following table:

HEIGHTS OF FAULKNER TERRACES					
Terrace	Machine used: to construct	Original height	Height after settlement	Decrease of height	Percentage decrease
F - 1	8" blade ter	1.42	1.20	0.22	15.5
F - 2	"	1.87	1.40	0.47	25.1
F - 3	"	1.43	1.23	0.20	14.0
F - 4	26" disc	1.60	1.20	0.40	25.0
F - 5	"	1.30	1.00	0.30	23.0

These data indicate that there is little difference in the rate of settlement of the terraces built with the two machines.

Conclusions:

The construction of terraces on the Red Plains Soil Erosion Experiment Station and on neighboring farms has provided the following conclusions as to methods and costs:

1. Cost of terrace construction will vary greatly with the experience, skill, intelligence, and vigor of the machinery operators.
2. Soil extremely dry and hard or extremely moist will increase the cost of construction.
3. A vegetative covering that will clog the machinery tends to slow down the rate of construction.

most of the effective savings by ceiling. Surveys were made in determining the change in extent of the business between 1919 and 1920. The following table, with results as shown in the following table.

[illegible]

most of the territory built with the new machinery.

1991-1992

subject that would not be as relevant to mathematics etc.

Department of Justice and Attorney General, Ottawa, Ontario

...the question of an ...

1. Cost of terrace construction will vary greatly with

transmission will be roughly the same, independent of the time, temperature and

• 72034450

1. This document is not to be distributed outside the organization.

increase the cost of construction.

twelve on each side (the left column contains six and the right column contains six).

and therefore to allow all work to be as planned

4. Short terraces are more expensive to construct than long terraces due to the increased percentage of time spent in turns.

5. Cost of construction per mile of terrace, not including depreciation of machinery, will decrease as the size of the terracing machine is increased, provided sufficient traction power is always supplied.

6. Satisfactory terraces may be built with any machine from the two horse moldboard plow to the 14 foot grader, providing the proper amount of perseverance is applied.

7. It requires more time and labor to build a terrace in heavy clay than in a sandy loam soil.

8. Roots, rocks, sprouts, and stumps add materially to the cost of terracing.

9. It costs about twice as much to terrace cultivated land with small gullies as it does to terrace cultivated land of a uniform nature. This ratio rapidly increases with the number and size of the gullies.

10. Terracing costs secured on soil of one definite texture and workability will not be applicable to a soil of another texture and degree of workability.

11. On slopes of less than about four per cent it is more economical to build terraces from both sides equally, but when the slope exceeds this amount, it is cheaper to work from the upper side only.

4. That the cost of construction per mile of tunnel, not including the cost of the increased percentage of time spent in tunneling, is estimated to be \$1,000,000.

5. Cost of construction per mile of tunnel, not including the cost of the increased percentage of time spent in tunneling, is estimated to be \$1,000,000.

6. That the cost of construction per mile of tunnel, not including the cost of the increased percentage of time spent in tunneling, is estimated to be \$1,000,000.

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11. That the cost of construction per mile of tunnel, not including the cost of the increased percentage of time spent in tunneling, is estimated to be \$1,000,000.

ADDITIONAL NOTES

12. Large road machinery will building terraces on hard, rocky ground not workable with small machinery.

13. The one-way disc plow, using discs 26 inches in diameter, will build terraces equivalent to those built with the blade terracer in approximately the same number of rounds. Only one man is required to operate the unit of tractor and one-way disc while two are required to operate the tractor and blade terracer. It is subject to a major disadvantage, however, in that it will not function efficiently on wet or very damp ground that may be easily worked with a grader.

Discussion of Results

The machine used in the test was a small tractor with a disc plow and a blade terracer. The machine was used to build terraces on a field of hard, rocky ground. The results of the test were as follows: The machine was able to build terraces on hard, rocky ground. The machine was able to build terraces in a shorter time than a grader. The machine was able to build terraces in a shorter time than a disc plow. The machine was able to build terraces in a shorter time than a blade terracer.

Conclusions

Based on the results of the test, it is concluded that a small tractor with a disc plow and a blade terracer is a suitable machine for building terraces on hard, rocky ground.

The large test equipment will require further work.

Every effort will be made to complete the work.

The work will be completed as soon as possible.

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EXPERIMENT No. 8.

Study of Farm Operations and Machinery on Terraced Land.

The object of this experiment is to determine the most effective and economical methods for preparation of seed bed, planting, cultivation, and harvesting of crops on terraced land. An effort is also made to suggest improvements in the design of machinery that will answer the requirements of farming parallel to the type of terrace ridge found most satisfactory for this locality.

The major crops raised in this section of the country are cotton, oats, corn, wheat, grain sorghums, and the various legume crops of alfalfa, sweet clover, soybeans, mungbeans, and cowpeas. These crops are nearly equally divided into row crop and drilled crop cultivation and as a result it is necessary to study and operate both types of machinery. Most cultivated fields are of comparatively small acreage and large machinery is not commonly in use.

Discussion of Machines in Use:

The machinery in use on the Red Plains Soil Erosion Experiment Station does not consist of any unusual number of different machines or of exceptionally large equipment. The principle has been to use equipment commonly found in this territory with a view to improvement for efficient operation over terraced land.

Vulcan Three Bottom Plow:

Much of the plowing on the station farm is done with a vulcan

1891

Group of two specialists and students in Technical Unit.

The object of this experiment is to determine the most

most satisfactory for this location.

The wheat crops raised in this section of the country are

The above information was obtained from a review of the records of the Bureau of Land Management, Department of the Interior, and the records of the National Forest Service, Department of Agriculture.

[illegible]

well as intended to reference

[illegible]

1915

Under a wide range of small animals will be naturally not to doubt

three bottom 16 inch plow equipped with a tractor hitch. Only two bottoms are used due to lack of sufficient power to handle all three. This machine is subject to no major disadvantages when used on terraced land so long as operations are conducted parallel to the terrace ridge. By proper arrangement of the plow strips the moldboards may be made to throw the dirt up to the peak of the terrace ridge from each side, thus building up the terrace with each plowing operation. It is practically impossible to use a machine of this type across the terrace because the shares dig deep into the ridge top resulting in serious decrease of effective height. At the point where plow strips join between terraces an unsightly deadfurrow is often created due to the variation in distance between terraces with slope of land. At points where this width suddenly increases, this deadfurrow will branch into two lines with a back-furrow between. If these furrows are not properly harrowed down they will conduct water from a considerable distance before allowing it to break into the main terrace channel. This concentration results in gully erosion between terraces.

Suggestions for improvement are included in the following statements:

1. The frog of the plow is too long on the model in use in Guthrie, shortening the life of shares, and making them difficult to force into the ground.

2. The plow is not adapted to short turning with a tread type tractor.

Oliver Single Bottom Plow:

This plow is not used a great deal on the Guthrie station

because it is not adapted to operation over terraced land. The one wheel gage employed on this type of plow does not prevent side slippage and therefore the utility of the plow is practically destroyed. A plow with three wheels to gage and prevent slippage is much more efficient in operation.

Wheatland One-Way Disc Plow:

The remainder of the plowing on the station farm is accomplished with a Wheatland One-Way Disc plow equipped with 26 inch discs (Figure 23). This machine can cover a larger area in a given time than the moldboard, plow, but will not plow to as great a depth. When the implement is used in normal plowing operations, on plow strips so arranged that the dirt will be thrown to the terrace ridge, a gain in terrace height of approximately six inches is usually apparent. By making additional rounds on the terrace ridge this increase in height will be made larger. When the disc plow is run directly across a solid terrace ridge, no great damage is done, but when the ridge is crossed at an angle, as in Figure 23, the total weight of the machine is concentrated on the center discs and a distinct lowering of the terrace results. It is most advisable to use the implement in operations parallel to the terrace ridge. Observation has also proven that it is not desirable to use a machine of this type in ground containing solid, well anchored roots. The thin edges of the disc cut into the root and bind, due to being set at an angle with the direction of pull. The forward motion of the machine creates a torque between the root and the disc which is often relieved by the tearing of the disc edge.

A one-way disc plow equipped with 23 inch discs, and loaned to the station through the courtesy of the Case Manufacturing Company, will

be tried out on terrace construction and maintenance and on field plowing during the year 1933. The diameter, radius of convexity of the discs, and spacing of discs offer the main possibilities for change in design of this type machine.

Tandem Disc and Spike Tooth Harrow:

For the preparation of seed bed on the station farm, the tandem disc, with 14 inch diameter discs, two five foot sections of spike tooth harrow, or the two in combination, are used (Figure 24).

The tandem disc is highly satisfactory for use on terraced land due to the implement being constructed in four sections of seven discs each. These sections are all connected in a manner sufficiently flexible to allow the machine to conform to the outline of terrace channel or ridge. The two section harrow has a similar degree of flexibility which may be further increased by placing a horizontal hinge in the center of the solid wooden evener shown in Figure 24. Even these machines should not be pulled with one section directly on the terrace ridge because of the resultant lowering of the terrace ridge (Figure 24). The same action results when the implements are pulled directly across the ridge instead of parallel to it.

John Deere Two Row Planter:

This machine was designed for use with a two horse team but is frequently used with a tractor on this station. Best results are obtained with the team.

The planter cannot readily be adjusted to prevent planting too deep in crossing the terraces. The machine has a tendency to slip down hill

when working on the side slope of the terrace ridges and as a result, the wheels do not follow in line with the runner openers and drop planters. Poor covering of the seed results. All makes of planters with this general design are subject to the same faults.

Suggestions for improvement of this planter for use on terraced land are:

1. The use of small diameter split wheels, at some sacrifice of light draft, placed at the absolute minimum distance from the drop planters might insure satisfactory coverage.
2. A leaning wheel adjustment which would permit simple change by the operator to counteract the effect of thrust on steep slopes.
3. Some means of shifting the planter on a sliding axle might be arranged to that at any time the wheels could be shifted into line behind the drop planters for proper coverage.

Moline Grain Drill:

A Moline nine foot grain drill with power lift is used in the planting of all grain crops. The length of the machine is such that when working over the terrace channel or on the side of the terrace ridge, the drills over the low part of the channel will not touch the ground, while those over the higher parts of the ridge will place the grain at too great a depth. When crossing the terrace the drills drive deep into the ridge with a resultant double damage in that the ridge top is lowered and the grain is planted too deep.

[illegible]

These faults might be corrected by dividing the long rigid drill section into rigid units of three or four foot length connected together in a flexible manner.

Moline One Row Cultivator:

This machine is a standard wheel guide cultivator with two gangs of three shovels each and foot and hand controls for moving each gang in horizontal and vertical planes. The main fault with the machine lies in its tendency to creep down hill when working on the steep slopes encountered on the terrace ridge. This creepage causes the machine to work in a continual skew, throwing the wheels at a slight angle with the direction of the row.

As a result it is difficult to properly control the location of the shovel gangs and plants are often covered or cut out. The wheels when turning in a skew will pick up dirt like a disc blade and cover young plants.

There is no simple method for adjusting the elevation of the different shovels in each gang, independently of the gang elevation. On the sideslopes of the terrace ridge the front shovel of the gang may be buried at the same time the rear shovel is barely touching the ground. This unequal penetration produces poor cultivation of the soil and leaves many weeds.

Suggested remedies for these faults are:

1. Thin fins on the wheels that will penetrate the soil and prohibit side slippage.
2. Some method of leaning wheel adjustment which could be readily made by the operator to balance the side slippage on various slopes.
3. A method of tilting each shovel gang in the plane of

1994-1995

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1. The first part of the paper is devoted to the study of the properties of the function $f(x)$ defined by the equation

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It is necessary to creep down hill when working on the steep slopes encountered

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Author's address: Department of Psychology, University of California, San Diego, 3542 La Jolla Village Drive, San Diego, CA 92093, USA. E-mail: shawn.wagner@ucsd.edu

At the time, the first source of family violence was crime, 74.9 percent.

... produces poor cultivation of the soil and leaves very weeds.

the wheel axles would insure even penetration of the shovels. This adjustment might also be made by raising and lowering each shovel individually.

Do-All Tractor Cultivator:

The Do-All general purpose tractor may be converted into a two row cultivator by removing the tractor front wheels and placing the cultivator attachment behind the drive wheels. Wherever possible this machine was used in the cultivation of crops. It was found that it was almost impossible to cultivate the top row on the terrace with the two-row cultivator since the wide distance between the wheels permitted the cultivator to dig in too deep and this could not be regulated (Figure 25). It was necessary to use a one-row horse cultivator for this purpose. It was found also that it was very difficult to use the two-row Do-All cultivator on the lower side of the terrace which was steeper than the upper side, (Figure 26). There was a tendency for the rear wheels of the Do-All tractor to slip down the slope which made it difficult to follow the row satisfactorily.

The second year no rows were planted on top of the terraces and it was found that the two-row Do-All cultivator could be used quite satisfactorily on the upper side of most of the terraces, but could not be used successfully on the lower and steeper side of the terraces with 20 to 25 feet base width. It was also found that a two-row cultivator could be used satisfactorily in crossing the terraces 25 to 30 feet wide at an angle of about 45°, but for smaller angles the same difficulty was encountered as in attempting to cultivate a row on the top of the terrace. Two outstanding criticisms of the tractor cultivator are the lack of self stabilization, which results in a tendency to creep when working on the side of a terrace, and lack of

Figure 25: Do-All tractor cultivator on top of terrace 5-B
cultivating row on each side of ridge top. Outer
shovels are out of ground. June 18, 1931.

5-2 advised he was no investigator - Agent 114-2

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... is ... deep ... a ... (Figure 27).
... often results in plowing out or covering the crop on top of the
...
... that they rise and fall with the ... of the tractor in creating a
... It seems that depth of plowing might be satisfactorily regulated by
the use of gauge wheels at each end of sufficient size and width to lift the
gauge in loose soil conditions. It is believed that a satisfactory degree of
stabilization and flexibility could readily be obtained by similar changes in
... which are necessary if the proposed stabilizer is to play a prominent
part in the farming of the rapidly expanding area of reclaimed land.

Observations

Under some of the ...
... a ... tractor ...
... observations ...

Figure 26: Do-All tractor working parallel to Terrace 5-B on lower side of terrace. Skew is so great that tractor wheel must rest on crop row to prevent plowing out crop of beans. June 18, 1931.

... with these ... of the ...
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... (Figure 28).

Figure 10: 3D plot showing the distribution of the data points in the 3D space. The axes are labeled X, Y, and Z. The data points are concentrated in a small region, indicating a high degree of clustering. The plot is a scatter plot with points colored in a gradient from blue to red.

flexibility in both the longitudinal and lateral planes of the cultivator. The tendency to creep or slip down the slope often results in plowing out or covering the crop. Lack of the proper flexibility is responsible for the shovels digging in excessively deep when crossing a terrace, (Figure 27), which often results in plowing out or covering the crop on top of the terrace. Less digging occurs where the location of the cultivator gangs is such that they rise and fall with the wheels of the tractor in crossing a terrace. It seems that depth of plowing might be satisfactorily regulated by the use of gage wheels at each gang of sufficient size and width to lift the gangs in loose soil conditions. It is believed that a satisfactory degree of stabilization and flexibility could readily be obtained by simple changes in design which are necessary if the tractor/cultivator is to play a prominent part in the farming of the rapidly expanding area of terraced land.

Grain Binder:

Twelve acres of oats on Terraces 3-C to 6-C were cut in 1931 with a seven foot binder drawn by a Caterpillar 15 tractor. (Figures 28 and 29). Observations made led to the following criticisms and suggestions:

1. The space between bull wheel and grain wheel is so great that the platform jams against the top of the terrace ridge when the wheels are run on opposite sides of the ridge top. When the machine is run with these wheels on opposite sides of the terrace channel the cutter bar cuts above or into the heads of the grain in the channel. (Figure 28).

flexibility is just the opposite and helps to the efficiency of the machine to creep or slip down the slope often results in blowing out the covering the crop. Even in the worst cases it is possible to have the machine slipping in excessively deep when crossing a terrace, (Figure 27), which often results in blowing out or covering the crop on top of the terrace. Thus digging occurs where the location of the distributor gangs is such that they slip and roll with the wheels on the terrace in crossing it. It seems that there is some kind of relationship between the use of rock wheels at the rear of the machine and the use of the rear wheels in loose soil conditions. It is believed that a satisfactory degree of stabilization and flexibility could readily be obtained by simple changes in design when the necessity is met. The following suggestions are made:

1. The turning of the machine on the ridge of a terrace is a

Design Suggestions

Five acres of oats on terraces 7-8 to 8-9 were cut in 1931 with a steam foot binder driven by a Caterpillar 15 tractor. (Figures 28 and 29) The following suggestions were made to the following conditions and suggestions:

1. The space between ball wheel and grain wheel is so great that the machine will not run on the ridge of the terrace. When the wheels are run on opposite sides of the ridge top. When the machine is run with these wheels on opposite sides of the terrace channel the cutter bar cuts above or into the heads of the grain

Figure 27: Do-All tractor cultivator crossing Terrace 5-B at right angle. Tractor wheels are just over ridge top. Beam is resting on ground and front cultivator shovels are buried. June 18, 1931.

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10-11-68
10-11-68

2. When crossing perpendicular to the ridge of a terrace of moderate cross section, the cutter bar cuts diagonally into the top of the terrace ridge, (Figure 28). This was caused by lack of sufficient adjustment for tilt from front to rear.

3. When crossing on the side of a terrace of moderate cross section, the bundle carrier will move into the upper side of the channel, turning the carrier back and rendering it feature to dump when oriented.

4. Difficulties with present machine lessen as the width of terrace is increased or as the length of carrier bar is decreased.

5. A plan binder if six or eight foot cutter bar, with all binder placed behind the bar, would approach very well on the terrace at the station form. Such a binder might be constructed to fit around the front and as a farm implement.

6. The ordinary mill binder might be adapted to use on terraces by introducing the following adjustment for greater

(a) a method should be devised whereby the machine can be tilted from front to rear and vice versa, using hydraulic pressure.

(b) large wheels and a power digger

Figure 28: Seven foot binder cutting oats in Channel of terrace 3-C. Note height of cutter above channel.

working the top of the terrace ridge.

(c) a flexible horizontal connection between the binder mechanism and the cutter bar and

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2. When crossing perpendicular to the ridge of a terrace of moderate cross section, the cutter bar cuts directly into the top of the terrace ridge, (Figure 29). This was caused by lack of sufficient adjustment for tilt from front to rear.

4 3. When cutting on the side of a terrace of moderate cross section, the bundle carrier will nose into the upper side of the channel, forcing the carrier back and resulting in failure to dump when tripped.

4. Difficulties with present machines lessen as the width of terrace is increased or as the length of cutter bar is decreased.

5. A push binder of six to eight foot cutter bar, with all mechanism placed behind the bar, would apparently work very well on the terraces at the station farm. Such a binder might be constructed to fit around the front end of a farm tractor.

6. The ordinary pull binder might be adapted to use on terraces by introducing the following adjustment for greater flexibility:

(a) a method should be devised whereby the machine can be tilted from front to rear and vice versa when crossing terraces.

(b) larger wheels and a proper regulating system to give a large range of vertical movement for the whole machine would be of value when working the top of the terrace ridges.

(c) a flexible horizontal connection between the binding mechanism and the cutter bar and

1. The machine is designed to be used in a position where the carrier is not too far from the front of the machine. This is caused by lack of sufficient adjustment for lift from front to rear.

2. The machine is designed to be used in a position where the carrier is not too far from the front of the machine. This is caused by lack of sufficient adjustment for lift from front to rear.

3. Difficulties with present machines lessen as the width of terrace is increased or as the length of outer bar is decreased. A push binder of six to eight foot outer bar, with a

4. The machine is designed to be used in a position where the carrier is not too far from the front of the machine. This is caused by lack of sufficient adjustment for lift from front to rear.

5. The machine is designed to be used in a position where the carrier is not too far from the front of the machine. This is caused by lack of sufficient adjustment for lift from front to rear.

6. The machine is designed to be used in a position where the carrier is not too far from the front of the machine. This is caused by lack of sufficient adjustment for lift from front to rear.

7. The machine is designed to be used in a position where the carrier is not too far from the front of the machine. This is caused by lack of sufficient adjustment for lift from front to rear.

8. The machine is designed to be used in a position where the carrier is not too far from the front of the machine. This is caused by lack of sufficient adjustment for lift from front to rear.

the top of the ridge and the bottom of the slope
the edge of the ridge at place 100.

The work was done by the Family Model General Machine

the John Deere Model B 1957 Tractor was used by the 1st class

the 1st class machine was used to cut the ridge at place 100.

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**Figure 29: Caterpillar 15 Tractor and seven foot binder
crossing at right angle to terrace ridge. Note
that cutter is striking ridge top.**

the 1st class machine was used to cut the ridge at place 100.

the 1st class machine was used to cut the ridge at place 100.

[illegible]

conveyor platform will allow the machine to conform to the shape of the channel or ridge top.

Tractors:

Two wheel type tractors, the Rumely Do-All General Purpose and the John Deere Model D 15:27 horsepower are owned by the Red Plains Soil Erosion Experiment Station. A caterpillar 15 horsepower tracklaying type machine was loaned to the station from July, 1930, to January, 1933.

It was found from the standpoint of traction particularly in crossing the comparatively loose soil in the tops of the terraces that the tracklaying type tractor had considerable advantage over the wheel type. The wheel tractor can not readily cross the terraces with the same load that it can easily handle between the terraces and much time is lost due to digging in and stalling in crossing a terrace, also resulting in considerable injury to the terrace. Also when working parallel to and on the side slope of a terrace embankment, the tracklaying tractor does not tend to slip down the slope as is the case for the wheel tractor. About the only disadvantage of the track laying tractor is the shock received by the tractor and operator when the tractor moves up one side of a terrace and drops down on the other side.

Miscellaneous Machines:

A Corsicana stalk cutter and a John Deere stalk cutter are used in all fields and are at no disadvantage on the terrace ridges. A McCormick-Deering Mower is used for cutting all hay crops and does satisfactory work in terraces by proper operation.

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Abstract

Special work in terraces by proper operation.

Conclusions:

From these observations it is apparent the major objection to existing farm implements when applied to terraced land are lack of self stabilization on steep slopes, lack of flexibility to accomodate sudden changes in surface, and impossibility of quick and ready adjustment.

It is impossible to build terraces to fit the requirements of all present farm machinery, therefore, it will be necessary to redesign some of these machines to conform to the requirements of terrace embankments found most satisfactory for each locality.

1941/1942

There is no objection to the proposal.

The following is the result of the survey.

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EXPERIMENT No. 9.

Building up Badley Eroded Land with Terraces, Green Manure, Cover Crops, and Fertilizers.

In this experiment an attempt is made to reclaim severely eroded and gullied land by preventing further erosion through the application of terraces, cover crops, and gully checks, and then improving the soil by the application of green manure crops and fertilizers. Plots 1 to 12 inclusive, located on Terraces 5-B to 9-B (Figure 1), comprise the layout.

The area used for this experiment was so severely eroded that it had been abandoned for agricultural use at the time this station was founded. The gullies were first reclaimed by small check dams of various types and terraces were then constructed. Data on this phase of the work is given under Experiment No. 10.

In 1929 and 1930, terraces 5-B to 9-B, were divided into Plot B, and Plots E-1, to E-6. The different plots in the order named were planted to mung beans, soy beans, sudan grass, cotton, sweetclover, cane and cowpeas in the year 1929. All crops except cotton were plowed under for green manure. The yield of cotton on plot E-3 was 89.0 pounds of lint cotton per acre. During the year 1930, all the plots were planted to cotton with yields as shown in Table 8. In the year 1931, the area was divided into the twelve smaller plots with a crop rotation scheme as layed out in Table 9. The agronomic features are under the supervision of the

Plot Number:	Treatment of Crop	Division:	Pounds of Seed Cotton per Acre for Crop Yield:			Remarks:
			1929	1930	1931	1932
B-1						
B-1			Mung beans	425.7		
B-2			Soy beans	223.5		
B-3			Sudan grass	197.5		
B-4			287	259.0		
B-5			Sweet clover	302.4		
B-6			Cane	517.0		
B-7			Cowpeas	350.6		
1	Cotton and Mung beans in alternate years				Mung beans	356.8
2	Cotton and Soybeans alternated:				Soy beans	286.5
3	Cotton-no cover, no fertilizer:	Limed			608.0	434.4
4	Cotton - Rye cover crop, 300 lbs. per acre of 4-12-4	Unlimed			384.4	350.7
5	Cotton - no cover crop - 300 lbs. per acre of 4-12-4	Unlimed			806.9	706.9
6	Cotton - Rye cover crop - no fertilizer	Unlimed			657.2	537.1
7	Cotton - no cover crop or fertilizer	Unlimed			816.1	590.8
8	Sweet clover alternating with cotton - limed and 100 pounds superphosphate per acre.	Unlimed			505.3	528.0
9	Cotton - winter legume cover crop - vetch	Limed			328.8	183.2
10	Cotton-Vetch winter cover crop: 300 lbs. 0-12-4: Unlimed	Unlimed			188.9	130.9
11	Cotton-fertilizer per acre	Unlimed			371.5	228.8
12	Cotton - Check - no treatment:	Limed			280.1	159.0
		Unlimed				
					Sweet clover: Sweet clover:	Sweet clover raised in 1931 and 1932
					Sweet clover: Sweet clover:	Terraces 8 and 9
					411.6	341.2
					545.7	472.6
					655.3	508.6
					667.6	662.0
					580.1	441.7
					890.2	701.8
					419.4	233.0
					714.9	382.2

Table No. 8

Plot :	Treatment of Crop	1931	1932	1933	1934	1935	1936	1937	1938
1.	Cotton and Mung beans in alternate years	Mung beans	Cotton	Mung beans	Cotton	Mung beans	Cotton	Mung beans	Cotton
2.	Cotton and Soybeans alternated	Soybeans	Cotton	Soybeans	Cotton	Soybeans	Cotton	Soybeans	Cotton
3.	Cotton-no cover, no fertilizer	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton
4.	Cotton - Rye cover crop, 300 lbs. per acre of 4-12-4.	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton
5.	Cotton - no cover crop - 300 lbs. per acre of 4-12-4.	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton
6.	Cotton - Rye cover crop - no fertilizer	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton
7.	Cotton - no cover crop or fertilizer	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton
8.	Sweet clover alternating with cotton - limed and 100 pounds superphosphate per acre.	Sweet clover limed	Sweet clover	Sweet clover	Cotton	Sweet clover limed	Cotton	Sweet clover limed	Cotton
9.	Cotton - winter legume cover crop - vetch	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton
10.	Cotton-Vetch winter cover crop: Cotton treated 300 lbs. 0-12-4:	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton
11.	Cotton-Vetch winter cover crop: Cotton treated 300 lbs. 4-12-4:	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton
12.	Cotton - Check - no treatment.	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton
13.	Cotton and cowpeas alternated. Unterraced field.	Cowpeas	Cotton	Cowpeas	Cotton	Cowpeas	Cotton	Cowpeas	Cotton
14.	Cotton and cowpeas alternated. 100 ft. closer level terraces.	Cowpeas	Cotton	Cowpeas	Cotton	Cowpeas	Cotton	Cowpeas	Cotton
15.	Cotton and cowpeas alternated. Level open-end terraces.	Cowpeas	Cotton	Cowpeas	Cotton	Cowpeas	Cotton	Cowpeas	Cotton

3 - 7 Lower two terraces limed at the rate of 1 ton of ground stone per acre 1931, 1934 and 1937.

Table No. 4

Bureau of Chemistry and Soils. Cotton yields for the years 1929 to 1932, inclusive, are listed in Table 8. The period of time covered by present data has not been sufficient to show a consistent trend toward increased crop yields.

Yields of seed cotton for terrace channel, terrace ridge, and interval area for the year 1931 and 1932, are shown in the following table. These yields represent weighted averages for each terrace and are not separated into the various plots:

YIELD OF SEED COTTON PER ACRE FOR CHANNEL, RIDGE, AND INTERVAL Terraces 5-B to 9-B							
1931				1932			
Terrace	Ridge	Channel	Interval	Ridge	Channel	Interval	
5-B	692.1	463.6	394.7	560.8	181.8	176.8	
6-B	663.1	562.8	464.6	521.6	439.4	385.8	
7-B	628.1	495.1	467.2	565.4	262.1	399.1	
8-B	633.4	557.2	481.3	604.6	375.6	402.2	
9-B	617.5	582.5	513.5	474.0	358.2	390.7	

It is interesting to note that for both these years the average yield of terrace ridge and channel, which represents the area disturbed in the terracing operation, is higher than the yield from the interval which was not disturbed. The ridge and channel yields individually were higher than the interval yield in 1931, but in 1932 the channel yield was slightly below the interval yield. This was caused by ponds which formed at old gully

crossings in the channel and remained there during the long series of
spring rains, thus drowning out much of the crop.

at various points.

Efforts were continued to determine the best methods,
materials, and costs for the construction of devices to check
erosion and prevent filling of the numerous gullies found on the erosion area.
In the spring of 1934 a number of gullies were filled with brush, poles,
and other material. All of these were available on the farm. Different
methods of construction were employed and the dams were built with different
heights, and spacings along the gully lines.

Construction in and East of Snake Creek

Dams which were built with brush, poles, and rock
in the gullies on the erosion area; of this number 6 were brush dams,
10 were pole dams, 3 were rock dams, 3 were pole dams and 14 were rock dams. The
length of the dams 11 were 10 feet long, 12 were 15 feet long, 13 were 20 feet long,
and 14 were 25 feet long. The dams were built in the gullies and the
erosion large areas.

Ordinarily the cost of constructing such dams on a farm will
depend largely on the availability of material and the distance that is
hauled. There seems to be no special reason for the construction of dams. The cost
of the dams would be greater than where the cost of putting and hauling

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... of the ... and ... the ... of the ...

... of the ... and ... the ... of the ...

1995	1996	1997	1998	1999	2000	2001
1995	1996	1997	1998	1999	2000	2001
1995	1996	1997	1998	1999	2000	2001
1995	1996	1997	1998	1999	2000	2001
1995	1996	1997	1998	1999	2000	2001
1995	1996	1997	1998	1999	2000	2001
1995	1996	1997	1998	1999	2000	2001

... of the ... and ... the ... of the ...

EXPERIMENT No. 10.

Filling in and Checking Erosion in Gullies and Preventing Erosion
of Terrace Outlets.

Experiments were conducted to determine the best methods, most suitable materials, and costs for the construction of devices to check erosion and cause filling of the numerous gullies found on the erosion station farm at the start of experimental work. Soil saving and check dams were built in these gullies with different materials such as brush, poles and old woven wire, all of which were available on the farm. Different methods of construction were employed and the dams were built with different widths, heights, and spacings along the gully lines.

Construction and Cost of Check Dams:

Sixty-one check dams were built with brush, poles, and rock in the gullies on the Guthrie farm; of this number 6 were loose brush dams, 35 were anchored brush dams, 6 were pole dams and 14 were rock dams. The length of the dams is taken as extending along the gully and the width as across the gully. This is contrary to the usual practice for dams built across large streams.

Ordinarily the cost of constructing such dams on a farm will depend largely on the availability of material and the distance that ^{it} is hauled. Where brush is cut especially for the construction of dams, the cost of the dams would be greater than where the cost of cutting and hauling

EXPERIMENT NO. 10.

Testing of the Various Methods of Fencing and Fertilizing

of Terrace Offsets.

Experiments were conducted to determine the best methods,

most suitable materials, and ways for the construction of fences to enclose
terraces and other things of the nature of the terrace offsets found in the various
places of the State of experimental work. Soil testing and other data
were taken in these places at the different intervals with the same soil
and all were also, all at which were suitable in the same material
methods of construction were suggested and the same also with the different
widths, heights, and spacings along the fully lines.

Construction and Cost of Check Dams:

Thirty-one check dams were built with brush, poles, and rock
in the valleys on the Guthrie farm; of this number 6 were loose brush dams,
12 were brush dams, 8 were pole dams and 14 were rock dams. The
length of the dam is taken as the distance from the first to the last
corner the dam. This is shown in the table showing the dam with
various large streams.

Approximately the cost of constructing such dams on a farm will
be about \$1000 to \$1500 per acre of material and the drainage benefits
realized. These figures are not especially for the construction of dams, but for
of the dam would be greater than shown the cost of building and draining.

brush could be charged to clearing the land. The labor of cutting and part of the hauling was not charged to clearing the cost of dams but was charged to the clearing of the land on the Guthrie farm. Such things should be taken into consideration by the farmer in estimating the cost of building check dams on his farm.

In Table 10, are given the average dimensions and cost of the different kinds of dams built. The average dimensions of the loose brush dams are 15 feet long, 4.1 feet wide, 2 feet high, and the average cost was \$0.98. These were the cheapest dams built.

The average dimensions of 10 stake and brush dams are 23.2 feet long, 8.3 feet wide, 3.0 feet high, and the average cost was \$11.87. The brush was carefully placed in these dams and the bottom of the gullies was covered with dry cane stalks.

Eighteen small pole and brush dams were built with average dimensions of 13.6 feet long, 6.4 feet wide, and 1.5 feet high, the average cost being \$4.16. Three dams were anchored with wire fastened to stakes driven into the bottom and sides of the gully, and the others were anchored with cross poles fastened to stakes on the top of the banks.

No particular care was taken in placing the brush for the other seven small pole and brush dams, and large open places were left in the brush. This reduced the cost of the building considerably. The average dimensions of these dams are 9 feet long, 4.6 feet wide, 1.0 foot high, and the average cost was \$1.39. These dams were much cheaper to construct, but somewhat smaller than the 18 dams which were carefully built.

They could be changed to almost any level. The lower of course was
that of the railing was not changed to anything the way of how but was
changed to the clearing of the land in the historic year. That being said
a table was constructed for the purpose of collecting the data of building
height based on his farm.

In Table 1, we show the average dimensions and area of the
different kinds of trees. The average dimensions of the trees were
ages are 12 feet long, 4.1 feet wide, 3 feet high, and the average area was
0.92. These were the average dimensions.

The average dimensions of 12 trees and more than 1000
trees long, 8.3 feet wide, 3.3 feet high, and the average area was 11.97.
The trees were mostly planted in their own soil the bottom of the hills
was covered with dry grass.

Planted trees were 12 feet long, 4.1 feet wide, 3 feet high, and the average
dimensions of 12 trees long, 8.3 feet wide, 3.3 feet high, and the average
area was 14.12. These trees were planted with the intention of them
being like the native and other of the hills, and the plants were collected

with these poles fastened to stakes on the top of the banks.

As mentioned above we have in this table the dimensions of the
other trees which were 12 feet long, 4.1 feet wide, 3 feet high, and the average
dimensions of these trees are 8 feet long, 4.1 feet wide, 3 feet high, and
the average area was 11.97. These trees were planted in groups of 100
planted under them for 12 trees which were mostly planted.

Kind of Dam	Average Dimensions:				Construction Data :				Remarks
	No. of Dams		Length:Width:Height:		Average per Dam :				
	Dams:	Length:	Width:	Height:	Man :	Material:	Hours:	Cost :	
Small loose brush	6	15.0	4.1	2.0	3.9	-	0.98	Loose brush thrown in gully with butts upstream. Gully filled half full. Rock placed on some of the dams.	
Large stake and brush, brush carefully placed	10	23.2	8.3	3.0	46.2	0.52	11.87	Brush laid flat with butts upstream. Held by wire and stakes.	
Small pole and brush, Brush carefully placed	18	13.6	6.4	1.5	16.3	0.10	4.16	Brush laid flat with butts upstream. Six were secured by wire and stakes and the remainder by crossed poles.	
Small pole and brush. Brush not carefully placed. No fine material:	7	9.0	4.6	1.0	5.1	0.12	1.39	Brush laid flat with butts upstream, and secured with poles in X shape across gully with ends staked down.	
Small Rock	13	1.6	5.7	0.5	2.8	-	0.71	Rocks placed tightly with straw underneath and on upper side except for three in which the rocks were placed loosely?	
Large Rock	1	3.5	6.7	2.0	11.0	-	2.75	Loose rock laid with straw between to make dam impervious	
Pole Dams	6	1.55	8.4	1.6	14.08	0.65	4.17	Bottom layer of poles laid lengthwise in gully, extending below dam to form apron.	
Concrete Baffles	6	-	3.5	1.8	7.2	4.08	3.24	Poles above laid crosswise extending into bank. Notch cut through top two layers. Poles held in place by spikes and wire. Concrete reinforced with hog wire.	
Concrete Baffles	4	-	13.5	0.9	19.8	7.73	13.67	Average depth of notch = 0.8 feet. Width of notch is taken as width of dam.	

TOTAL 27

The average length, width, height, and cost of six pole dams is given in Table 10. The average length is 1.55 feet, width 8.4 feet, height 1.6 feet, and the average cost \$4.17.

Fourteen rock dams were built, thirteen of which were small rock dams ranging in depth from 6 inches to 9 inches. The building of these dams did not require much labor. The average dimensions are 1.6 feet long, 5.7 feet wide, 0.5 feet high, and the average cost was \$0.71. One comparatively large rock dam was built. This dam is 3.5 feet long, 6.7 feet wide, 2.0 feet high, and cost \$2.75. In building these rock dams, straw was placed among the rocks to prevent the silt from washing through the holes. Where this method was not employed, it was almost impossible to prevent silt from washing through the dam.

Some conclusions drawn from observation and experiments with check dams built in gullies on the Guthrie farm are shown below:

1. Low dams are more successful than high dams since the water falls a shorter distance below the dam, and there is less tendency to erode the bottom of the gully. The pressure of water above high dams is sufficient to force out silt that has accumulated in the open spaces of the more porous dams. From the standpoint of both economy and successful operation, it is believed that a height of about 2 feet is the most satisfactory for check dams in small gullies.

2. The greater the flow of water in the gully the stronger should be the anchorage of the dam. The flow of water in the gully depends upon the size of the drainage area.

The average length, width, height, and cost of all dams built in 1912. The average length is 1.12 miles, width 0.12 miles, height 1.6 feet, and the average cost \$4.17.

Twenty-two dams were built, thirteen of which were small rock dams ranging in length from 0.12 to 0.25 miles. The height of these dams did not average much more. The average height was 1.6 feet high, 0.7 feet wide, 0.6 feet high, and the average cost was \$4.17. The average height of the rock dams was 1.6 feet high, 0.7 feet wide, 0.6 feet high, and the average cost was \$4.17. In building these dams the following were placed among the rocks to prevent the soil from washing through the dam. There this method was not employed, it was almost impossible to prevent soil from washing through the dam.

Some construction dams from observation and experience with which dams built in 1912 on the basis of the above data:

1. Low dams are more successful than high dams since the water falls a shorter distance before the dam, and there is less tendency to erode the bottom of the dam. The tendency is of water above high dams is reflected in the fact that the water is in the open spaces of the more porous dams. From the standpoint of both economy and successful operation, it is believed that a height of about 2 feet is the most satisfactory one when dams in small gullies.

2. The greater the flow of water in the gully the stronger should be the foundation of the dam. The flow of water in the gully depends upon the size of the drainage area.

Brush dams without anchorage have not been found satisfactory. In small gullies with a very limited drainage area, some form of light anchorage such as a few loose rocks, should be placed on top of the brush.

3. The sides of the gully at the location of dams should be protected against washing to the top of the bank or at least as high as the water in the gully is expected to rise. The most common failure of check dams consists of erosion at one or both ends of the dam.

4. An apron¹ should be built below impervious dams to prevent the falling water from eating back under the dam. This is also a very common ~~xxxxx~~ cause of failure of check dams.

5. For the best results, the top of one dam should be placed at the level of the bottom of the dam above. The results of the experiments showed that it would be possible to place the dams further apart than this since a ~~fill~~ fill occurred the total distance between the dams in Gullies F and G. However, it is believed that better results will be obtained where the rule is observed.

6. The check dams should not reduce the cross-section of the gully sufficiently to cause the water to overflow the banks, as this usually results in the erosion of a new parallel gully down the slope.

There have been several cases of landslides in the vicinity of the dam, and it is believed that the dam is safe. The dam is built on a very strong foundation, and the water is kept at a low level. The dam is built of concrete, and the water is kept at a low level. The dam is built of concrete, and the water is kept at a low level.

8. The sides of the gully at the location of the dam should be protected against sliding in the event of the dam being raised or high as the water in the gully is expected to rise. The most common method of doing this is by placing a row of posts or both ends of the dam.

It is strongly recommended that the dam be built on a very strong foundation, and the water is kept at a low level. The dam is built of concrete, and the water is kept at a low level. The dam is built of concrete, and the water is kept at a low level.

9. For the best results, the top of one dam should be placed at the level of the bottom of the dam above. The results of the experiments showed that it would be possible to place the dam higher than the water level. The dam is built of concrete, and the water is kept at a low level. The dam is built of concrete, and the water is kept at a low level.

It is believed that the dam will be safe. The dam is built of concrete, and the water is kept at a low level. The dam is built of concrete, and the water is kept at a low level. The dam is built of concrete, and the water is kept at a low level.

7. More rapid filling above a brush dam occurs where the bottom of the gully is covered with grass, straw or other similar material, the finer brush placed next to the straw, and the larger brush placed and packed so as to reduce open spaces in the brush to a minimum. This method tends to prevent erosion along the sides or bottom of the gully which results in washing out a hole and undermining the dam.

Life of Check Dams:

The rock dams constructed on this project have as yet shown no signs of deterioration. Time appears only to solidify this type of dam by adding a heavy blanket of silt, grass roots and the like.

The brush dams seem to have a useful life from two and one half to three years. In Figure 30 is shown a V-notch brush dam in Gully G that is practically disintegrated after three years service.

Pole dams are subject to fairly rapid decay, but on the average will last about one year longer than the brush dam and are more efficient in silt stopping ability. In Figure 31 is shown a pole dam in apparently good condition after three years of service, while in Figure 32 this same dam is shown as a complete failure after three months of additional service during which a series of heavy rains occurred.

Figure 33 is a view of a woven wire dam located in Ravine A. A substantial fill of silt, leaves, and branches has deposited behind the dam during three years of service. This type of dam is efficient and economical for depths of fill not exceeding three feet.

Figure 30: Brush dam at lower end of Gully G. Note how brush has rotted and fallen in after three years of service. April 8, 1932.

Figure 31: Brush dam at lower end of Gully G. Note how brush has rotted and fallen in after three years of service. April 8, 1932.

There are two main types of ... and of ... Note how ...

Figure 31: Pole dam after three years service, located at lower end of Gully F. Note that fill back of dam is level with notch. April 8, 1932.

Figure 31: Pole dam after three years service, located at lower end of Gully F. Note that fill back of dam is level with notch. April 8, 1932.

It is desired that after three years service, (limited to
from out of duty & from duty out of pay
in leave with pay, July 1, 1911)

Figure 32: Failure of pole dam at lower end of Gully F.
This dam was installed in 1929. July 7, 1932.

Figure 33: Water view from the road to
the dam at the lower end of Gully F.

I agree to use your name as you wish to use it. I will not
 make any other use of your name without your written consent.

Soil Survey, 1932

An earth wall earlier now was constructed in Ravine 3 (Figure 1) during 1931, as aid in the reclamation of this ravine and as a roadway to the place in the northeast corner of the dam. The dam is now above this dam is about 1,500 feet in length and contains 115,000 cu yds of material. The dam is now at the foot of the hill - crest width of 18 feet. It is 10 feet high above the original surface of the ravine. Discharge through the dam is handled by a concrete pipe from culvert two feet in diameter and 38 feet long. This pipe is laid in the solid ground forming the original ravine bank rather than in the old fill in order to prevent settlement and distortion. The discharge of the pipe at the upstream end is placed three feet below the surface of the dam and at the downstream end is placed about one foot above the bottom. The effective head on the pipe is about eight feet with a two foot freeboard on the dam. Erosion at the outlet is prevented by a concrete apron 10 feet long. Total cost of the dam including material and labor was \$10,000.

A masonry masonry soil saving dam was built in Ravine A during the year 1932. This dam is now at the foot of the hill - crest width of 18 feet. It is 10 feet high above the original surface of the ravine. Discharge through the dam is handled by a concrete pipe from culvert two feet in diameter and 38 feet long. This pipe is laid in the solid ground forming the original ravine bank rather than in the old fill in order to prevent settlement and distortion. The discharge of the pipe at the upstream end is placed three feet below the surface of the dam and at the downstream end is placed about one foot above the bottom. The effective head on the pipe is about eight feet with a two foot freeboard on the dam. Erosion at the outlet is prevented by a concrete apron 10 feet long. Total cost of the dam including material and labor was \$10,000.

Figure 33: Woven wire dam in Ravine A. Note the accumulation of silt behind the wire. April 8, 1932.

The dam is now at the foot of the hill - crest width of 18 feet. It is 10 feet high above the original surface of the ravine. Discharge through the dam is handled by a concrete pipe from culvert two feet in diameter and 38 feet long. This pipe is laid in the solid ground forming the original ravine bank rather than in the old fill in order to prevent settlement and distortion. The discharge of the pipe at the upstream end is placed three feet below the surface of the dam and at the downstream end is placed about one foot above the bottom. The effective head on the pipe is about eight feet with a two foot freeboard on the dam. Erosion at the outlet is prevented by a concrete apron 10 feet long. Total cost of the dam including material and labor was \$10,000.

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Soil Saving Dams:

An earth soil saving dam was constructed in Ravine B (Figure 1) during 1931, to aid in the reclamation of this ravine and to serve as a roadway to the plots in the southeast corner of the farm. The drainage area above this dam is about 1,300 feet in length and contains 12.5 acres of cultivated land. The crest length of the dam is 50 feet with a crest width of 12 feet. It is 10 feet high above the original bottom of the ravine. Discharge through the dam is handled by a corrugated iron culvert two feet in diameter and 32 feet long. This pipe is laid in the solid ground forming the original ravine bank rather than in the soft filled in dirt to prevent settlement and distortion. The centerline of the pipe at the upstream end is placed three feet below the crest of the dam and at the downstream end is placed about one foot above the ravine bottom. The effective head on the pipe is about eight feet with a two foot freeboard on the dam. Erosion at the outlet is prevented by a concrete trough 10 feet long. Total cost of the dam including materials and labor was \$138.74.

A mortared masonry soil saving dam was built in Ravine A during the year 1932. This dam, (see Figure 34), was laid with sound rock and cement mortar to a height of four feet above the gully bottom. The mortared rock extended into a trench cut two feet into the bottom and sides of the ravine. A masonry apron and stilling pool was built to form a pool six feet long measured from the toe of the dam and one foot deep. The masonry wall forming the dam is two feet thick at the bottom and one foot at

SOIL SAVING DAM

An earth soil saving dam was constructed in Ravine B

(Figure 1) during 1932. It is in the immediate vicinity of the dam and is
situated on a hillside in the west of the dam. The dam is about 1,500 feet in length and contains
12.5 acres of cultivated land. The total length of the dam is 10 feet
with a crest width of 12 feet. It is 10 feet high above the original
bottom of the ravine. Discharge through the dam is handled by a cover-
ed pipe which is 10 feet in diameter and 10 feet long. This pipe is
set in the hill through the original bottom of the ravine. The
in the soil filled in this is covered with concrete and masonry. The
structure of the pipe at the bottom and is placed there that the
crest of the dam and the foundation and is placed there that the
the ravine bottom. The effective head on the pipe is about eight feet
with a ten foot freeboard on the dam. Flow at the outlet is prevented
by a concrete structure in the pipe. The cost of the dam was \$128.74.

A masonry masonry soil saving dam was built in Ravine A

during the year 1932. This dam, (see Figure 2), was built with sound rock
and concrete masonry at a height of ten feet above the water surface. The
dam was extended into a trench and ten feet above the water surface and
the ravine. A concrete structure was built in the dam and
the dam was extended from the top of the dam and was built in
masonry well extending the dam to the top of the dam and was built in

The dam, which was filled in as a 2 in 1 slope behind the dam.

The foot including the stone and later was 600 ft.

In connection with the construction and maintenance of the

work an observation was made that:

1. The dam may be built deeper into the river with
the bottom of the dam off the rocks.

2. The dam may be built on a foundation of concrete
spurs or piers to withstand large forces of water.

3. Long walls must be built carefully and of equal
height to accommodate various flows.

4. A properly designed stilling pool must be provided
below the dam to prevent erosion under the toe of the dam. The
length of this pool should be at least one and one half times the
height of the dam, and the depth should be about one fourth the
height of the dam. These figures are based on observation of
stilling dams and not on hydraulic laws, therefore the figures
are approximate.

5. A dam of rock laid carefully without mortar to a
height of two feet in this case ravine failed under the first
flow of the water.

**Figure 34: Rock dam laid with mortar to height of four
feet in Ravine A. May 27, 1932.**

REMARKS ON THE DAM:

Various outlet protective devices were installed on the river
from 1928 to 1932 during the year 1932. Three of these protective devices were

Figure 84: Rock dam laid with mortar to height of four feet in Ravine A. May 27, 1922.

the top. Earth, well tamped was filled in at a 2 to 1 slope behind the dam. The total cost including materials and labor was \$25.00.

In connection with the construction and maintainance of this type of dam observation has shown that:

1. The dam must be sunk deeply into the ravine sides and bottom to cut off seepage.

2. The dam must be solidly constructed and mortared together closely to withstand large flows of water.

3. Wing walls must be built staunchly and of ample height to accomodate maximum flow.

4. A properly designed stilling pool must be provided below the dam to prevent erosion under the toe of the dam. The length of this pool should be at least one and one half times the height of the dam, and the depth should be about one fourth the height of the dam. These figures are based on observation of existing dams and not on hydraulic tests, therefore the figures are approximate.

5. A dam of rock laid carefully without mortar to a height of two feet in this same ravine failed under the first flow of any magnitude, proving that this type of construction will not withstand large flow such as comes from the 35 acres of land draining into the ravine.

Terrace Outlet Protection:

Terrace outlet protective devices were installed on terraces 5-B to 9-B during the year 1932. Three of these protective devices were

The top. Water, well tested and fitted is at 2 on 1 side below the top.

The total cost including materials and labor was \$25.00.

The committee will be responsible for maintenance of the

type of dam operation has shown that:

1. The dam will be built below the water level

and bottom to cut off seepage.

2. The dam will be built on a foundation of rock

together closely to withstand large flow of water.

3. Wing walls must be built staunchly and of masonry

to prevent seepage around the dam.

4. A proper drainage system must be provided

below the dam to prevent standing water from the dam. The

length of this pool should be as small as possible and not less than 100

feet to the dam, and the dam should be built on a foundation of

rock to the dam. These figures are based on a foundation of

solid rock and not on a foundation of loose material. Therefore the figures

are approximate.

5. A dam of rock laid carefully without mortar is a

dam of low cost in time and money and is the best

type of dam available, provided that the flow of water is not

so great as to cause such a dam to be washed away from the dam

of low drainage into the river.

Future Plans

Future plans include the building of a dam on the river

to be built during the year 1922. These plans are subject to change.

constructed of poles (See Figure 35) on the same principle used in pole check dams. The other two devices were of rock as shown in Figure 36. These five structures all fulfilled their purpose with complete satisfaction during the heavy rains of 1932. There was no cost involved in securing material for these outlet protections since rock and poles were available on the farm. The labor used amounted to approximately six man hours for each device, including procurement of material and installation.

In building these units it was necessary to observe the following precautions to insure satisfactory results:

1. It was necessary to sink a trench to hard footing, usually one foot deep, and start the rock or pole construction on this base to prevent seepage and undercutting.

2. Straw or hay was forced into all crevices and placed in a sheet behind the device to insure the catching of silt.

3. Wing walls were built to ample height above the dam so that all water would pass over the crest of the structure and not around the ends.

At the outlets of terraces 7-E, 8-E, 9-E, and 10-E, two other types of protection were installed. One of these consisted of sheets of corrugated iron cut into short lengths such that when driven the maximum possible distance into the soil, the upper end of the sheet was at terrace grade. One sheet at each end was allowed to project one foot above terrace grade to serve as a wing-wall. The other type consisted of small straight stakes driven side by side in a line across the channel. The tops of the stakes in the center of the device were driven to terrace grades and several of those at each end of the line were driven to a point one foot above grade to serve as wing-walls.

Figure 35: Terrace outlet protective device with wide notch constructed of pyramided poles at outlet of Terrace 8-B. Filling occurred during spring of 1932. October 10, 1932.

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The corrugated roofing was more expensive since it involved the purchase of material in addition to labor of installation. Cost of material was \$0.80 for each unit in addition to four more hours labor. For the devices using stakes, the material was secured on the farm, and eight man hours labor were required to secure, prepare, and rive the stakes for each unit.

Ditch Protection:

The ditch which drains all terraces in Plot 15-A was thoroughly protected against erosion by creosoted plank baffles installed in the year 1932. Each baffle had a crest length of six feet with wing-walls one foot high above the crest and fastened to the mainboard at a 45 degree angle. The only protection made against undercutting of the baffles consisted of setting the bottom of each baffle slightly below the crest of the baffle downstream. The cost of material for each baffle was \$1.50 for ten linear feet of 3" X 12" creosoted bridge lumber. Two man hours labor were needed for each installation. It was found necessary when refilling the trench in which the plank baffles were set to mix some straw with the earth backfill and to tamp the fill thoroughly. This prevented the filled in dirt from washing out. These baffles all gave excellent results during the rains of 1932.

Creosoted lumber checks were also installed in the ditch which drains the B terraces into Ravine A. This ditch is a flat bottomed ditch 14 feet wide in the bottom and two feet deep. Baffles were constructed of one creosoted plank 2" X 12" X 16'-0" with win-walls of the same material fastened

at a 45° angle on each end. The same method of installation was followed as that used in the Plot 15-A ditch. Cost of material for each baffle consisted of \$2.40 for 24 feet of creosoted 2" X 12" plank. Three man hours labor were required for the installation of each baffle.

An attempt was made to prevent erosion in the ditch draining the terraces in Field C by the use of rock checks laid without mortar. The checks were built of large rock laid carefully without mortar and chinked with straw. Only one of the checks was over two feet in height and the crest of each was level with the base of the check just upstream. These checks were filled level with silt after the first large runoff and effectively prevented erosion of the channel. It was noted, however, that the largest storms caused excessive flows of water which loosened the rock in several of the dams. If not carefully maintained, after each storm, it is probably that this type of structure would soon be destroyed.

From this date it appears that checks to prevent erosion in terrace outlet ditches must be built in an integral unit to withstand the large flow of water.

at a rate of 100 cfs. The discharge of the dam is controlled by the gate in the first 10-A ditch. Good of material for each ditch is estimated at 10,000 cu yds. for 24 feet of excavation 24 X 12" ditch. Three can hours labor was required for the excavation of each ditch.

An attempt was made to prevent erosion in the ditch drainage. The estimate is that 6 by the use of rock checks laid without mortar. The checks are built of large rock laid carefully without mortar and checked with straw. Only one of the checks was over two feet in height and was cross of each was laid with the base of the check just upstream. These checks were filled with silt after the first large runoff and effectively prevented erosion of the ditch. It was found, however, that the large flow of water which loosened the rock in several of the dams. It was found that the checks were not strong enough to hold the rock in place. It is thought that the use of concrete checks would soon be destroyed.

From this it is seen that the dam is in a very poor state of repair and that it is in need of a complete reconstruction. It is suggested that the dam be reconstructed with concrete and that the gate be replaced by a concrete gate. The dam is in a very poor state of repair and it is suggested that the dam be reconstructed with concrete and that the gate be replaced by a concrete gate.

EXPERIMENT No. 11.

Soil Movement Down the Slopes

Lines are laid perpendicular to the contours in several locations on the station farm (Figure 1) to determine the rate of soil movement down the slopes of unterraced land, level terraced, land, and graded terraced land. Permanent concrete bench marks are set at the upper and lower ends of each line.

Accurate measurements are made each year to determine the elevation of points along these lines at intervals of one foot, with the soil in practically the same condition as to physical characteristics. The effectiveness is measured by the extent to which this soil movement is retarded and a comparison of the profiles along these lines affords information on this subject.

It is thought that information ~~is~~ obtained from these experiments will not be of value before a period of five years has elapsed and that the longer the experiment is continued, the more valuable will be the results obtained.

EXPERIMENT NO. 12.

Runoff from Small Watersheds with Different Characteristics

Measurements of runoff and soil loss are made on small watersheds with different conditions of cover and cultivation.

The following small watersheds comprise this experiment:

(1) A wooded watershed containing 5.62 acres indicated on the map as Plot 1.

(2) A badly gullied and eroded watershed containing an area of about 5.28 acres is designated as Plot J. This is an abandoned area, formerly cultivated, now covered with a growth of wild grasses and weeds.

(3) A level terraced watershed, consisting of the area between Terraces 1-R and 5-E and designated as Plot 15-A on the map, contains an area of 3.13 acres.

(4) A cultivated watershed, with rows running across the slope, contains an area of 3.61 acres and is designated as Plot 13 on the map. After the fall rains in 1932, terraces 5-B and 1-E were connected across the upper part of Plot 13 to prevent possible entrance of outside drainage waters. This reduced the area to 3.23 acres.

(5) In the summer of 1932 it was decided to include level terrace 6-E in this series of plots so that the runoff and soil losses from this terrace could be compared with those from unterraced Plot 13. This terrace is 620 feet long, has an

EXPERIMENT NO. 12.

Small Plot 12, Experiment 12, 1932-1933

Measurements of runoff and soil loss are made on small

plots with different conditions of cover and cultivation.

The following small plots were established in 1932:

(1) A small plot, 10 feet by 10 feet, established

on the top of Plot 1.

(2) A small plot, 10 feet by 10 feet, established

on the side of Plot 1, 10 feet from the top edge. This is

an abandoned area, formerly cultivated, now covered with a

growth of grass and weeds.

(3) A level terrace watershed, consisting of the

area between Terraces 1-B and 5-B and designated as Plot 12-A

on the map, contains an area of 3.13 acres.

(4) A small plot, 10 feet by 10 feet, established

on the top of Plot 1, 10 feet from the top edge. This is

Plot 12 on the map. After the fall of 1932, the top of Plot 12

and 1-B were connected across the upper part of Plot 12 to pro-

vide possible entrance of surface drainage water. This changed

the area to 2.33 acres.

(5) In the summer of 1933 it was decided to include

level terrace 6-B in this series of plots so that the runoff

and soil losses from this terrace could be compared with those

from watershed Plot 12. This terrace is 630 feet long, has an

average vertical interval of 4.0 feet, and has a drainage area of 1.30 acres on land with an average slope of 4.56 per cent.

(6) An area having a close cover of native grass and small shrubs, with absolutely no gullies or bare spots was selected on the East Farm of the Erosion Station at the time 6-E was opened. This plot has an area of 2.50 acres with an average land slope of 5.9 per cent.

Parshall measuring flumes, automatic water level recorders, and Ramser silt sampling units are installed on all these watersheds except Plot J, which doesnot have a silt sampling unit.

Percentages of rainfall which appeared as runoff, and soil losses in tons per acre from these plots for the year 1931 are listed in Table 13, and for the year 1932 in Table 14.

Losses for year--Plot L.

For the year 1931, only 0.76 per cent of the rainfall ran off from Plot L with a cover of woods and brush. In 1932, due to increased rainfall, this figure was 2.0 per cent. The total runoff for the two years of record on this plot was only five per cent of that on Plot 13, the cultivated, untterraced watershed. The low water loss for the wooded area is due probably to the increased absorptive capacity of the soil rather than to the small storage capacity of the forest litter. The runoff water contains little silt and as a result the tiny pores of the soil are not clogged by deposits from the percolating water. As long as pores are open percolation will continue and the soil will absorb more moisture. Some storage also

average vertical interval of 4.0 feet, and has a thickness of 1.15 feet on land with an average slope of 0.9 per cent.

(c) An area having a close cover of native grass and

small shrubs, with absolutely no gullies or bare spots was selected

on the west side of the drainage basin in the 1932-33 year

period. This plot has an area of 2.50 acres with an average

land slope of 0.9 per cent.

Partially wooded forest, consisting of native grass, shrubs

and forest with varying amounts of timber, on all three watersheds

Year 1, which does not have a close cover.

Percentages of rainfall which appeared as runoff, and soil

losses in each year were from these plots for the years 1932 and 1933

Table 12, and for the year 1933 in Table 14.

Table 12 - Runoff

For the year 1932, only 0.47 per cent of the rainfall was lost

from this area as runoff. In 1933, for the same watershed

year, this figure was 3.0 per cent. The total runoff for the two years

of record on this plot was only 1.47 per cent of the rainfall.

When the entire land for the watershed was considered, runoff

was 1.47 per cent of the rainfall. The runoff from the

small stream at the head of the drainage basin

is 1.47 per cent of the rainfall. The runoff from the

entire watershed was 1.47 per cent of the rainfall.

will continue and the soil will be washed away.

results through the interception of the rainwater by leaves and branches of trees and brush. Most of this is probably soon lost through evaporation.

Soil loss per acre on this wooded plot was 0.03 tons in 1931, and 0.18 tons in 1932. The total loss for the two years on Plot 13, the cultivated, unterraced watershed, was 429 times the amount lost during the same period from Plot L. The small amount of runoff from this plot, all at low intensities, cannot cause any serious erosion. The cover of litter on the soil prevents the water from attaining sufficient velocity to have any cutting power and strains many of the particles of soil that are in the water.

Losses for Year--Plot J.

Measurements of runoff only are made from Plot J. During 1931 this eroded and gullied area of native sod lost 11.2 per cent of the year's rainfall as runoff, and in 1932, the loss was 10.1 per cent.

Runoff percentages for Plot J show the effect of the many gullies which cut the sod cover in this area. These collect the runoff water and concentrate it at the outlet of the area in a more flashy manner than would be the case with an uneroded, grassed area. This area is not typical of bare, eroded fields such as Plot 13 because of the tendency for surface storage in the grass cover. Observation has shown that during the winter months freezing causes serious spalling of the gully banks, thus depositing large amounts of soil in the gully bottoms. During the spring rains the intense flows down the gullies carry out these deposits. These flows also undercut the banks at bands and cause large chunks to fall down

and be carried off by the flow in the gully channel. Further enlargement of the gullies is effected by the small rivulets of water which drop over the banks during periods of runoff. As the gullied area enlarges, the area covered with sod decreases and the runoff percentages must increase, creating higher rates of runoff and erosion from year to year. From these observations, it is evident that the most economical time to begin gully control is in the incipient state of formation.

Losses for Year--Plot 15-A:-

Only 19.7 per cent of the rainfall on level terraced Plot 15-A appeared as runoff during the year 1931, and for 1932, the percentage was 19.8. It is surprising that the figures should be so nearly identical for such different types of rainfall years. The percent of rainfall for each year which appeared as runoff is considerably below that of unterraced Plot 13, and in 1932 the percentage figure on Plot 15-A was less than two thirds of the value on Plot 13, and stands in about the same ratio to graded terraces 2-B and 3-B. It is believed that this difference is due to increased absorption of moisture on the level terraced area, but more data is needed before a definite conclusion can be drawn. That this moisture is of no benefit to crops is shown by the fact that for all years of record the yield on Plot 15-A has been much lower than on Plot 13. This is due to the drowning of much of the crop in the terrace channels.

Soil loss from Plot 15-A was at the rate of 7.57 tons per acre in 1931, and 15.70 tons per acre in 1932. These figures are high due to erosion in the channel of the ditch which drains the five terraces, and due to

deposits in the ditch of windblown sand which are in turn carried to the measuring unit. The ditch is now fully protected by plank baffles with grass planted between, and should give more accurate results during the year 1933.

Losses for Year. Plot 13:-

The per cent of rainfall during 1931 was 22.70 per cent on Plot 13, and in 1932, due to increased rainfall, this figure was 30.8 per cent. These percentages are practically the same as those for graded terraces 2-B and 3-B for the same years. The soil lost during the year 1931 was 43.9 tons per acre and during the year 1932 this figure increased to 88.1 tons per acre or a total of 132 tons per acre for the two years. Soil loss from long graded terraced 2-B, cropped in a somewhat similar manner and located on the same eroded slope was 14.99 tons per acre for the two years of record. The unterraced area thus lost 8.8 times as much soil as the long graded terrace due to the unrestrained flow and consequent high intensities of runoff on the unterraced area. The soil loss from Plot 13 for the two years of record was 12.5 times as large as that from terrace 4-B which is 1,500 feet long and has a constant grade of 4"/100 feet.

Losses for Year. Terrace 6-E and Pasture Area:-

These two runoff areas were both installed after the first half of the year 1932 and results are available only for the fall rains. There was absolutely no runoff from the pasture area during any of the storms due to the close cover of native grass and small shrubs which had not been pastured. Results from terrace 6-E are discussed under individual storm measurements.

...in the ditch of windblown sand which are in turn carried to the
...The ditch is now fully protected by glass bottles with

1. The East zone and has a constant grade of 4"/100 feet.

These two kennels were both located about the 1st of May 1962 and were the only ones which were still active at the time of the investigation. The kennels were located in the area of the 1st of May 1962 and were the only ones which were still active at the time of the investigation.

Runoff and Soil Losses by Storms, 1932:-

Measurements of rainfall, runoff, and soil losses, on the terraces comprising this experiment are listed in Table 11 for the seventeen storms which occurred in the year 1932. Hydrographs of runoff, cumulative rainfall curves, and block graphs of rainfall intensity for the storms of June 24th and October 3rd, 1932, are shown in Figures 37 and 38 respectively.

Study of the intensities of runoff as listed in Table 11, and in the hydrographs shows that in all cases the intensities from Plot 13 were fully twice as large as those from any of the terraces. These large intensities on the untterraced areas result in high velocities of flow with resultant increase in erosive power of the flowing water.

A comparison of Plot 13 and level terrace 6-E, which are located on identically the same soil and slope, and are cropped in exactly the same way for the storms of August 16th, October 3rd and 25th, and December 23rd, shows that Plot 13 lost 33.1 and 74.3 times as much soil per acre for the first two storms, that Plot 13 lost 2.26 tons per acre as compared to none from Terrace 6-E for the third storm, and that Plot 13 lost 42.0 times as much soil for the December storm.

Conclusions:-

1. A cover of woods and brush insures percolation of rainwater into the soil, thus preventing runoff and erosion.

2. Large gullies, when left unhindered in abandoned grass lands tend to enlarge from year to year and will in time completely consume the area.

Study of the intensities of rainfall

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TABLE No. 11

Small Watersheds With Different Characteristics
Measurements of Rainfall, Run-off, and Soil Loss For Principal Storms During the Year 1932
Red Plains Soil Erosion Experiment Station Near Guthrie, Oklahoma

Date	Average Rates of Rainfall					Total	Maximum Rates of Run-off										Total Run-off In										Soil Loss in Tons Per Acre											
	Rainfall					Period	Plot 13		Plot 15A		Ravine A		Plot J		Plot L		Terrace 6-E		Plot 13		Plot 15A		Ravine A		Plot J		Plot L		Plot 13		Plot 15A		Plot J		Plot L			
	10	15	20	30	40		Feet	In./hr.	Feet	In./hr.	Feet	In./hr.	Feet	In./hr.	Feet	In./hr.	Feet	In./hr.	Feet	In./hr.	Feet	In./hr.	Feet	In./hr.	Feet	In./hr.	Feet	In./hr.	Feet	In./hr.	Feet	In./hr.	Feet	In./hr.				
July 11	0.48	0.48	0.44	0.39	0.34	2.22	0.61	0.17	0.58	0.18	6.56	0.18	0.61	0.12	a	a	e	e	9.35	16.7	27.3	9.1	a	e	0.37	0.13	a	e	Plot 13 was a permanent cover of timber, brush, and grass.									
" 11	0.36	0.30	0.28	0.27	0.23	0.74	a	a	0.06	0.02	0.97	0.03	a	a	a	a	e	e	a	3.3	2.8	a	a	e	a	0.11	a	e	Plot 15A was a permanent cover of native sod cut with numerous gullies.									
" 11	0.72	0.60	0.56	0.51	0.42	1.13	1.05	0.29	0.51	0.16	8.13	0.23	0.41	0.08	0.03	0.01	e	e	18.40	34.3	41.3	11.3	1.0	e	1.21	0.24	0.001	e	Terrace 6-E is a level terrace and flat long with a feet vertical spacing. Plot 13 contains 5.51 acres of cultivated land not terraced.									
Aug. 18	2.16	1.80	1.40	1.17	0.88	0.50	1.40	0.38	0.20	0.06	1.12	0.03	0.31	0.06	a	a	e	e	9.86	2.0	6.3	2.7	a	e	0.77	0.02	a	e	Plot 15-A has five level terraces on 3.13 acres of cultivated land. Ravine A drainage area comprises 35 acres of terraced land. These four Plots supported winter wheat cover during the winter months of 1931-32 and were plowed with a moldboard plow during the first week of April 1932. Cotton was planted in contoured rows on May 17, 1932, cultivated on June 15 and July 20, and picking was completed on October 14, 1932. A cover crop of winter wheat was planted on October 17, 1932.									
Aug. 31	6.00	4.68	4.20	4.35	3.84	2.96	22.53	6.17	7.49	2.38	61.53	1.72	9.54	1.80	0.61	0.11	e	e	70.60	32.1	49.8	17.4	1.3	e	14.52	3.27	0.006	e										
Sept. 3	0.96	0.84	0.64	0.63	0.52	0.91	0.54	0.15	0.14	0.05	3.56	0.10	a	a	a	a	e	e	21.60	5.7	2.3	a	a	e	a	0.11	a	e										
" 4	2.28	1.86	1.86	1.44	1.14	1.09	6.80	1.36	2.96	0.94	22.17	0.62	3.44	0.65	0.23	0.04	e	e	74.60	56.0	60.4	24.2	3.0	e	1.47	1.60	0.003	e										
" 5	1.92	1.68	1.64	1.44	0.90	0.73	3.62	0.39	1.08	0.34	22.17	0.62	1.05	0.20	0.06	0.01	e	e	60.30	24.0	44.8	9.7	1.2	e	5.23	0.47	0.006	e										
" 23	1.92	1.56	1.44	1.38	1.32	0.90	1.37	0.37	0.35	0.11	1.02	0.06	0.93	0.18	0.03	0.01	e	e	13.30	6.0	6.3	12.3	1.4	e	2.72	0.13	a	e										
" 24	4.80	3.84	3.60	3.54	3.24	2.84	20.76	5.33	8.49	2.69	67.05	1.98	13.63	2.37	4.06	0.70	e	e	94.30	79.0	60.0	3.3	13.4	e	20.77	5.05	0.103	e										
" 26	0.48	0.36	0.32	0.30	0.28	0.83	0.31	0.08	0.22	0.07	4.05	0.11	a	a	0.02	0.01	e	e	30.20	14.2	30.0 ^b	a	1.1	e	1.18	0.02	0.012	e										
" 26	1.56	1.02	0.84	0.84	0.72	0.42	1.37	0.38	0.39	0.31	13.96	0.45	0.93	0.17	a	a	e	e	50.50	25.1	49.2	17.4	a	e	2.39	0.13	0.044	e										
Oct. 5	4.56	3.72	2.88	2.34	1.64	1.76	21.53	5.93	8.49	2.69	58.15	1.63	13.13	2.47	1.37	0.24	e	e	53.50	52.0	54.0	35.5	10.3	e	15.20	2.34	0.010	e										
October 13	3.36	2.64	2.24	1.92	1.52	2.76	5.12	1.40	0.24	0.08	21.24	0.60	1.44	0.27	0.25	0.04	d	d	17.50	9.4	40.0 ^b	2.8	0.9	10.0	5.63	0.34	a	0.17										
October 13	3.64	3.72	2.96	2.40	1.70	1.02	19.55	5.35	d	d	15.55	0.44	1.05	0.20	0.30	0.05	0.49	0.45	54.50	20.0 ^b	20.1	5.1	0.9	15.8	4.46	0.45	a	0.06										
" 13	1.76	1.24	2.88	2.25	1.52	2.14	3.40	0.93	0.90	0.29	0.90	0.03	a	a	a	a	a	a	27.00 ^b	13.5	5.6	a	a	a	2.26	0.20	a	a										
Oct. 14	0.72	0.60	0.44	0.42	0.38	2.78	0.93	0.25	0.23	0.07	1.20	0.03	a	a	a	a	0.12	0.10	42.80 ^b	8.7	15.0 ^b	a	a	14.4	3.42	0.05	a	0.08										
																																	</					

Note:

- a - No run-off or no soil loss
b - Total run-off estimated
d - No record due to instrument failure
e - Silt sampling unit and Recorder not installed

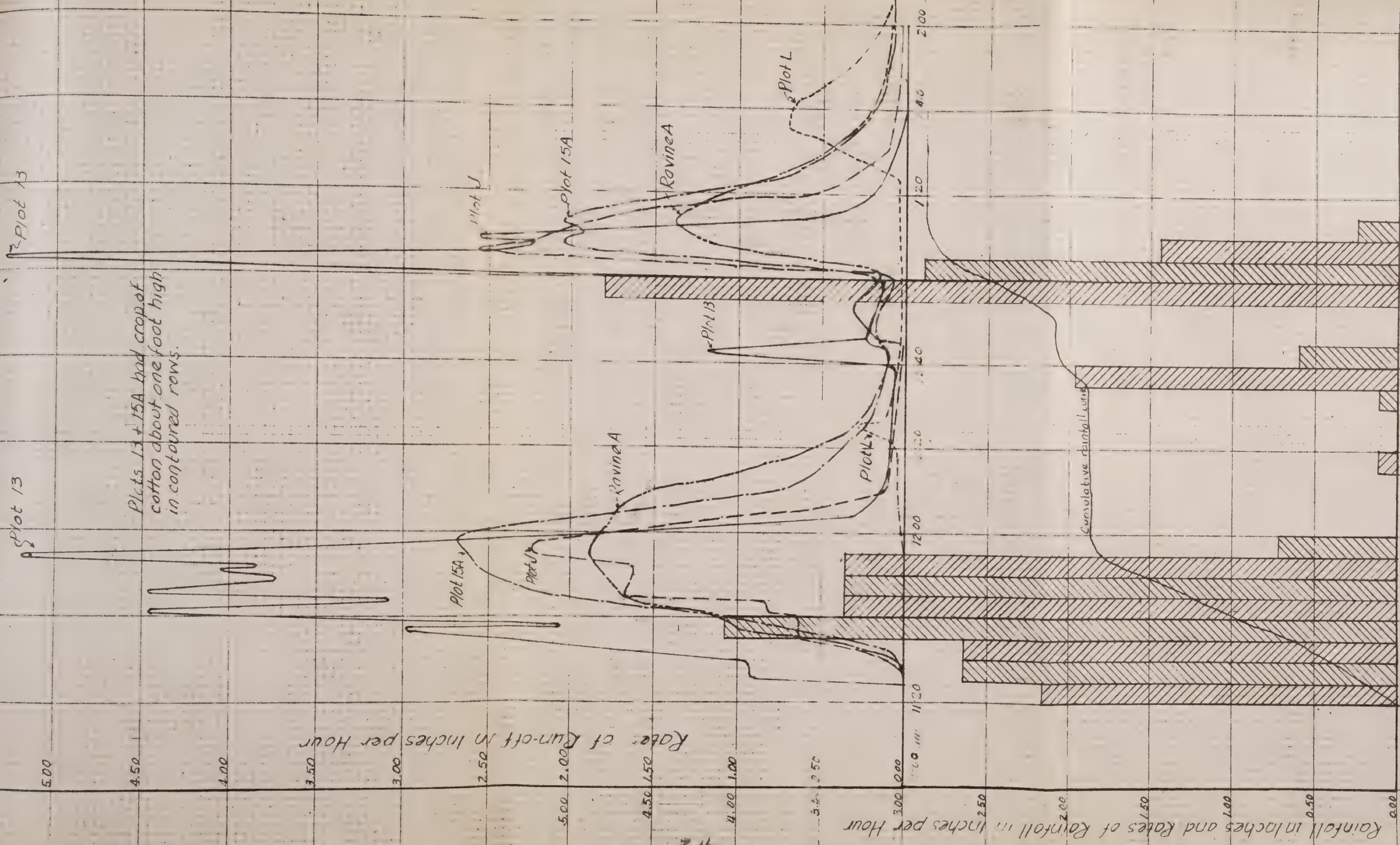


Figure 37 - Cumulative rainfall and rates of rainfall and run-off for small watersheds with different characteristics, as follows: Plot L = 5.6 acres, wooded; Plot J = 5.3 acres, gullied grass land; Plot 13 = 3.6 acres, cultivated and not terraced; Plot 15A = 3.1 acres, cultivated, with five level terraces; Ravine A = 35.0 acres of terraced land. Land slopes vary from 3.5' to 5' per 100'. Rain of June 24, 1933.

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Figure 38 - Cumulative rainfall and rates of rainfall and runoff for small watersheds with different characteristics, as follows --- Plot L = 5.6 acres, wooded, Plot J = 6.3 acres, gulched grassland, Plot I3 = 3.6 acres, cultivated and not terraced; Ravine A = 35.0 acres of terraced land. Land slopes vary from 3.5 to 5.0 'per 100'. Rain of October 3, 1932.

3. Runoff in per cent of rainfall, from gullied grass lands is much higher than runoff from areas with unbroken cover and is less than from cultivated areas.

4. Percentage of rainfall appearing as runoff on cultivated areas with level terraces is less than the runoff from areas with graded terraces or from fields not terraced.

5. Conservation of moisture by level terraces on the eroded Vernon soil of the Guthrie station caused decreased crop yields during the four years of record by drowning of the crops in the terrace channels.

6. The per cent of rainfall which ran off unterraced and cultivated Plot 13 was about the same as the per cent figures on the graded terraces.

7. Soil loss from Plot 13 was at nine times the rate of loss from a terrace one-half mile long with a variable grade from 0" to 4"/100', 12.5 times the rate of loss from a terrace 1,500 feet long with a constant grade of 4"/100', 25 times the rate from a level terrace 1,500 feet long and at a rate varying from 33 to 74 times the loss from a short level terrace under exactly comparable conditions.

3. Runoff in per cent of rainfall, from cultivated areas

is less than from uncultivated areas.

and is less than from uncultivated areas.

4. Percentage of rainfall appearing as runoff on cultivated areas

is less than from uncultivated areas.

with graded terraces or from fields not terraced.

5. Conservation of moisture by level terraces on the

grapes from soil in the terraced fields is less than from

fields which are not terraced.

is the same amount.

6. The per cent of rainfall which ran off unterraced

and unterraced fields is less than from the same amount

as the graded terraces.

7. Soil loss from Plot 13 was at nine times the rate of

loss from a terrace which was at a rate of 1.000

to 1.500, and the rate of loss from a terrace 1.500

to 2.000, and the rate of loss from a terrace 2.000

to 2.500, and the rate of loss from a terrace 2.500

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to 3.500.

EXPERIMENT NO. 13.

Subsoiling Terraced and Unterraced Land.

As has been stated under Experiment No. 4, a subsoiling experiment was conducted on terraces 1-F and 2-F. The north portion of the terraces was subsoiled to a depth of about 14 inches and the south portion was plowed in the usual manner. The subsoiling was done in the fall of 1929 and was repeated again in the early part of 1932. From the crop yield records listed under Experiment No. 4, it may be seen that the subsoiling caused no increase in yields. The water standing in the subsoiled portions of terraces 1-F and 2-F disappeared about four days, or 19 per cent earlier in 1931 than was the case on the land plowed in the usual manner. This time element was apparent in about the same ratio for the year 1932. This slight shortening of total time after rains before farm operations can be resumed, would not justify the expense of subsoil plowing. It may be, however, that in years of very low rainfall the effect of subsoiling this particular type of land would be sufficient to justify the operation. Further data must be obtained before conclusions can be drawn. Another experiment to determine the effect of subsoiling was conducted on a neighboring farm. An area of 5.98 acres was obtained for this purpose, and a gully running roughly north and south through the central part of the area was selected as a division line between the two plots. The west plot, amounting to 3.31 acres, was subsoiled to a depth of about 14 inches and the east plot of

2.67 acres was plowed in the usual manner. The slope of this land is quite uniform and averages about 4.5 per cent. The total area was planted to cotton during the years 1930 and 1931 and a record of yields was kept.

L I N T C O T T O N F I E L D S (In pounds)			
Plot	1930 Yield	1931 Yield	
Subsoiled	84 per acre	82 per acre	
Normal	73 per acre	72 per acre	

This difference in yield of approximately 10 pounds of lint cotton per acre cannot be entirely attributed to the subsoil operation since a soil survey indicates that the plot which was subsoiled has a slightly better soil than the non-subsoiled plot. Even if this were not the case an increase as small as recorded would not justify the added cost of subsoil plowing with cotton selling from 6¢ to 10¢ per pound.

EXPERIMENT NO. 14.

Tile Drainage of Level Closed End Terraces.

This experiment will afford information on the effectiveness of a tile drainage system when applied to level terraces designed to retain all the rain water. In the early months of 1932, a tile drainage system was installed on the portion of terrace 2-F that lies south of the central dividing levee. This is the area that is plowed in a normal manner to compare with the subsoiled area north of the levee.

Forty feet of drain tile four inches in diameter were laid in the channel of Terrace 2-F at the extreme south curve, and covered with loose rock to a depth of one foot. About one foot of topsoil was placed above the rock. The outlet "T" was placed at the center of the forty foot section and was concreted in place. The outlet tile line, 190 feet long, leads from the south point of terrace 2-F along the divide between Fields B and C to a point just below terraces 3-B and 2-C where it empties into an open ditch. The fall of the outlet line is four feet per hundred feet of line.

The water entered the tile rapidly after storms, but the head of the outlet line was so great that the soil above the rock inlet was forced through the openings between the rock, leaving an open ditch in the terrace channel. This trouble continued during most of the major storms of 1932. For smaller storms the tile drained the excess water from the terrace channel in a shorter time than was noted for Terrace 1-F. For storms of this type, there was not sufficient standing water in the terrace channels to give a fair measure of the efficiency of tile drainage. The tile system will be reconstructed in 1933 and further comparisons of effectiveness made.

EXPERIMENT NO. 15.

Runoff and Soil Losses from Large Terraced and Unterraced Cultivated Watersheds.

This experiment affords information on volume and intensity of runoff from comparatively large fields when terraced, when not terraced, and under different conditions of soil and cover.

Terraces 1-B and 9-B inclusive, and the north ends of the A terraces comprise the Ravine A watershed which together with the drainage area of the Cottonwood River above Guthrie represent the present layout for this experiment.

A Parshall measuring flume of three foot throat width was installed near the head of Ravine A for the purpose of measuring the volume and intensity of runoff from the 35 acres of terraced land in the watershed.

The installation of the measuring flume was not completed until late in the fall of 1931, and as a result, runoff measurements are available only for the rains of November. For 8.10 inches of rainfall during November, 1931, the per cent appearing as runoff was 11.90 inches which was considerably lower than corresponding figures on unterraced Plot 13, and on most of the individual terraces in Fields A, B, and C.

Runoff measurements by seasons and for the total year 1932 are listed in Table 14. These figures compare closely with those for terraces in Fields A, B, and C, and are considerably below those for unterraced Plot 13.

The hydrographs of runoff for the Ravine A area during the storms of June 24th, and October 3rd, 1932, are shown in Figures 37 and 38. These graphs indicate that runoff from the terraced area is of low intensity and uniformly distributed over the storm period.

WATER IN THE NORTH

Small and Soil losses from large Terraces and Unterraced

Drainage Terraces

Small and Soil losses from large Terraces and Unterraced
Drainage Terraces

Terraces 1-B and 3-B inclusive, and the north ends of the A
terraces mostly the same as the south ends of the A
terraces at the Ottumwa River above Guthrie represent the present layout
the same as the south ends of the A

A terrace consisting of two or three terraces with an
inclination from the back to the front of the terrace is shown in the
plan of the terrace from the 30 acres of terraced land in the watershed.
The terraces of the watershed from the 30 acres
with a fall of 1.5 ft. to 2 ft. in a mile, which represents the
average fall of the entire watershed. The 30 acres of terraced land
represent 10% of the total area of the watershed. The 30 acres of
terraced land represent 10% of the total area of the watershed. The 30
acres of the terraced land represent 10% of the total area of the watershed.

Small and Soil losses from large Terraces and Unterraced
Drainage Terraces

An automatic water level recorder is installed on the Cottonwood River in Guthrie. A gaging station is installed in connection with this recorder and staff gages are installed for measurement of the slope of the water surface over a known course. It is planned that these measurements will give accurate knowledge of the river flow for all seasons, under different conditions of flood flow, and with various channel conditions. Samples of the flow will be taken at regular intervals after the experimental work is well under way to secure a measure of the soil carried from the drainage area of the stream. Collection of data from this experiment will not start until in the spring of 1933.

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EXPERIMENT NO. 16.

Strip Cropping in Combination with Small Terraces.

The value of a combination of strip cropping and small terrace ridges on land severely damaged by sheet erosion is the subject studied in this experiment.

The experiment is located on the east portion of Field D, (See Map, Figure 1). The land in this field, which has an average slope of about 5.5 per cent, is severely affected by sheet erosion.

Five small terraces, approximating large back-furrows, were built on the area in the latter part of 1932. The ridges were each built in seven rounds with an Oliver eighteen inch single bottom sulky plow. Upon completion they averaged about seven feet in width and were about eight inches high. The ridges are level and drain to the east.

It is the purpose of this study that everything connected with it shall be as practicable as possible and capable of construction by any farmer with the tools that he already has available for use in his other farm work. A strip of alfalfa extends 15 feet on each side from the center of each small terrace. The interval between these small strips will be planted each year in a row crop of cotton, corn or cowpeas with the upper edge of the alfalfa strips as the base line for planting. Any short rows which may develop shall be pointed up into the lower side of the next higher alfalfa strip.

The ordinary farm practices such as plowing, cultivating, and planting will be carried out in the usual manner except that they shall be performed parallel to the alfalfa strips. The effect of this combination of erosion control methods will be measured in terms of crop yields, and, if funds permit, by the use of some type of measuring device. Records of this type will not be available until the year 1935.

EXPERIMENT NO. 16.

Strip Cropping in Combination with Small Terraces.

The value of a combination of strip cropping and small terraces

in this experiment.

The experiment is located on the west portion of Field No.

1000 (Fig. 1). The land in this field, which has an average slope of

Five small terraces, approximately 10 ft. high, were

built in the area in the latter part of 1933. The ridges were each built in

seven yards with an Oliver eighteen inch single bottom subsoiler. Upon

completion the average level was 10 ft. and was small terraces

built in. The ridges are level and drain to the east.

It is the purpose of this study that everything connected with

it will be as profitable as possible and as little as possible to the soil.

One of the things that we always find in the soil is that the

water is not so much as it is in the soil. It is not so much as it is in the

small terraces. The interval between these small terraces will be placed every

year or so and it will be found that the soil is not so much as it is in the

small terraces as the base line for planting. Any more rows which are

small terraces will be pointed up into the lower side of the next higher terrace

small

The second year (1934) will be similar, with the same

planted will be similar to the first year, but in the second year the soil will be

planted in the same way. The object of this experiment is

to find out if the soil is not so much as it is in the first year, but in the

second year, if the soil is not so much as it is in the first year, but in the

type will not be available until the year 1935.

EXPERIMENT NO. 17.

Gully Control Studies on Pasture Land.

To check erosion and reclaim gullies on pasture land by means of check dams, forest trees, shrubs, and native grasses is the object of this experiment.

A severely eroded 110 acre farm, abandoned for agricultural use, located east of the east fence of the erosion station was loaned by the State of Oklahoma as an experimental tract.

Groups of typical and comparable gullies have been selected with the view of comparing various methods of gully control within each group. A check against gullies with no control will also be obtained in each case. In some instances a study of mechanical methods alone, and in other, forest and shrub growth alone will be used. A combination of methods will be carried out in some gullies.

Check dams will be constructed of stone and brush obtained on the farm. The shrubs, wild plums, and buckbrush will be obtained locally. The forest trees consist principally of black locust, Chinese elm, and orange, native grasses, principally blue stem, will be allowed to grow and their effects on checking erosion will be observed. When trees are used they will be planted back of the dams, along the sides, and in the lower part of the gullies. They will be spaced approximately five feet apart, depending upon size. This experiment is to be put in at the lowest possible cost, to show that a farmer can do gully control work at little or no cash outlay. Which will be furnished, at no cost, by the State Forester of Oklahoma.

This is a joint project by the Bureau of Agricultural Engineering and the Bureau of Chemistry and Soils of the U. S. Department of Agriculture; and Agronomy Department of Oklahoma A. & M. College of Stillwater, Oklahoma, which is furnishing the farm on which the experiment is located; and the State Forester of Oklahoma, who is furnishing the forest trees, without cost.

The work of installing check dams will be completed in the spring of 1933. Records of cost of construction will be carefully made along with observations as to the efficiency of the various dams.

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1200 South 1st Street

1. The first step is to identify the problem or question that needs to be answered. This involves understanding the context and the specific requirements of the task.



Ter- Drain- aver- T e r r a c e										Total Run-off Soil Loss										Surface Condi- Crop										Season									
Race		Age		Vorti-Grate		In. Length		In. Per		In. Per		In. Per		In. Per		In. Per		In. Per		In. Per		In. Per		In. Per		In. Per		In. Per		In. Per		In. Per		In. Per		In. Per			
Water-		of		of		of		of		of		of		of		of		of		of		of		of		of		of		of		of		of		of			
shed		in		in		in		in		in		in		in		in		in		in		in		in		in		in		in		in		in		in			
No.		Acres		Ft/100		Feet		Feet		Feet		Feet		Feet		Feet		Feet		Feet		Feet		Feet		Feet		Feet		Feet		Feet		Feet		Feet			
1-A		0.59	5.35	2.00	4	700	1.80	23.37	2.32	0.302	1.232	Young corn	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
1-A		0.59	5.35	2.00	4	700	0.03	0.91	0.02	0.005	0.549	Mature corn	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
1-A		0.59	5.35	2.00	4	700	1.05	9.50	0.83	0.075	0.789	Bare Ground	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
1-A		0.59	5.35	2.00	4	700	2.88	10.66	3.17	0.118	1.107	Young corn	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
6-A		0.56	5.60	2.00	4	700	1.54	17.40	1.27	0.165	0.948	Young corn	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
6-A		0.56	5.60	2.00	4	700	0.27	6.88	0.16	0.041	0.596	Mature corn	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
6-A		0.56	5.60	2.00	4	700	3.28	29.76	0.88	0.060	0.869	Bare Ground	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
6-A		0.56	5.60	2.00	4	700	4.89	18.09	2.31	0.086	0.475	Young corn	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
2-A		0.99	5.46	3.50	4	700	1.51	19.57	2.42	0.315	1.610	Young corn	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
2-A		0.99	5.46	3.50	4	700	0.28	7.21	0.18	0.046	0.538	Mature corn	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
2-A		0.99	5.46	3.50	4	700	3.11	28.22	2.01	0.182	0.645	Bare Ground	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
2-A		0.99	5.46	3.50	4	700	4.90	18.13	4.61	0.171	0.943	Young corn	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
5-A		0.92	5.76	3.50	4	700	1.81	29.51	1.30	0.169	0.719	Young corn	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
5-A		0.92	5.76	3.50	4	700	0.30	7.84	0.18	0.046	0.602	Mature corn	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
5-A		0.92	5.76	3.50	4	700	3.72	34.20	1.84	0.167	0.488	Bare Ground	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
5-A		0.92	5.76	3.50	4	700	5.88	21.76	3.32	0.123	0.565	Young corn	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
3-A		1.38	5.45	5.00	4	700	1.46	18.95	2.65	0.345	1.820	Young corn	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
3-A		1.38	5.45	5.00	4	700	0.14	3.63	0.16	0.041	1.129	Mature corn	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
3-A		1.38	5.45	5.00	4	700	2.85	25.85	2.99	0.271	1.048	Bare Ground	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
3-A		1.38	5.45	5.00	4	700	4.45	16.46	5.80	0.215	1.306	Young corn	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
4-A		1.34	5.58	5.00	4	700	1.00	13.00	2.39	0.311	2.392	Young corn	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
4-A		1.34	5.58	5.00	4	700	0.16	4.05	0.11	0.028	0.690	Mature corn	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
4-A		1.34	5.58	5.00	4	700	2.60	23.58	1.67	0.151	0.640	Bare Ground	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
4-A		1.34	5.58	5.00	4	700	3.75	13.91	4.17	0.155	1.114	Young corn	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
1-C		6.16	3.54	3.91	0 to 4	2550	1.11	14.08	1.08	0.137	0.973	Fallow	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
1-C		6.16	3.54	3.91	"	2550	0.14	3.57	0.10	0.025	0.714	Cotton	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
1-C		6.16	3.54	3.91	"	2550	2.19	19.55	0.77	0.068	0.352	Cotton stalks	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
1-C		6.16	3.54	3.91	"	2550	3.44	12.59	1.95	0.072	0.566	Young corn	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
2-B		5.99	2.79	3.99	0 to 4	2556	1.93	24.42	3.18	0.403	1.648	Fallow	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
2-B		5.99	2.79	3.99	"	2556	0.14	3.57	0.17	0.043	1.212	Cotton	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
2-B		5.99	2.79	3.99	"	2556	4.47	39.90	1.32	0.118	0.295	Cotton stalks	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
2-B		5.99	2.79	3.99	"	2556	6.540	23.94	4.67	0.172	0.715	Young corn	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
3-B		5.67	3.70	3.45	0 to 6	2856	1.64	20.79	3.45	0.436	2.103	Fallow	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
3-B		5.67	3.70	3.45	"	2856	0.20	5.10	0.15	0.038	0.750	Cotton	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931		
3-B		5.67	3.70	3.45	"	2856	4.47	39.90	1.67	0.149	0.373	Cotton stalks	Jan 1 to March 31		7.5		July 1 to Sept 30	Oct 1 to Dec 31	Total for 1931	No Run-off Occurred during the period		Jan 1 to March 31																	



TABLE NO. 6

Summary of Run-off and Soil Loss on All Terraces and Watersheds for the Year 1942 with Both Seasonal and Yearly Totals
Red Plains Soil Erosion Experiment Station near Guthrie, Oklahoma.

Total Rainfall = 36.20 inches.

Total Rainfall = 36.20 inches.

Ter- race	Drain-	Aver- age Slope	Age of Land	Area in Acres.	Ft/100	Feet	Terrace Grade	In Length	Total Run-off	Oil Loss	Surface Condi- tion of ater-	Crop Yield Per Acre
No.	Shed	Slope	Area	Drain-	Age	Feet	Grade	Per Cent	Inches	Per Inch	Of Fallow, etc.	Season
1-A	0.59	5.35	2	4	700	0.82	9.7	3.55	0.247	0.532	Fallow	Jan. 1 to May 15
1-A	0.59	5.35	2	4	700	6.67	4.4	3.55	0.247	0.532	Oats	May 15 to July 15
1-A	0.59	5.35	2	4	700	1.41	10.6	0.02	0.001	0.014	Cowpeas	July 15 to Dec 31
1-A	0.59	5.35	2	4	700	3.30	24.6	3.37	0.099	0.401		Total for 1932.
6-A	0.56	5.60	2	4	700	0.97	11.5	0.37	0.044	0.361	Fallow	Jan. 1 to May 15
6-A	0.56	5.60	2	4	700	7.09	49.3	2.74	0.190	0.366	Oats	May 15 to July 15
6-A	0.56	5.60	2	4	700	1.91	14.4	0.47	0.035	0.245	Cowpeas	July 15 to Dec 31
6-A	0.56	5.60	2	4	700	9.96	27.6	3.33	0.099	0.401		Total for 1932.
2-A	0.98	5.46	3.5	4	700	0.56	6.6	0.23	0.033	0.507	Fallow	Jan. 1 to May 15
2-A	0.98	5.46	3.5	4	700	6.91	43.1	3.07	0.214	0.444	Oats	May 15 to July 15
2-A	0.98	5.46	3.5	4	700	0.52	7.9	0.14	0.014	0.465	Cowpeas	July 15 to Dec 31
2-A	0.98	5.46	3.5	4	700	7.99	27.1	3.34	0.098	0.443		Total for 1932.
5-A	0.92	5.76	3.5	4	700	1.03	12.6	0.34	0.076	0.604	Fallow	Jan. 1 to May 15
5-A	0.92	5.76	3.5	4	700	6.31	44.3	1.84	0.128	0.292	Oats	May 15 to July 15
5-A	0.92	5.76	3.5	4	700	1.45	1.9	0.05	0.054	0.389	Cowpeas	July 15 to Dec 31
5-A	0.92	5.76	3.5	4	700	9.23	25.5	3.20	0.093	0.347		Total for 1932.
3-A	1.38	5.45	5	4	700	0.71	8.4	0.46	0.057	0.676	Fallow	Jan. 1 to May 15
3-A	1.38	5.45	5	4	700	6.29	36.8	1.40	0.137	0.454	Oats	May 15 to July 15
3-A	1.38	5.45	5	4	700	1.13	0.0	0.42	0.012	0.472	Cowpeas	July 15 to Dec 31
3-A	1.38	5.45	5	4	700	7.1	19.8	2.80	0.079	0.461		Total for 1932.
4-A	1.34	5.58	5	4	700	0.60	7.1	0.32	0.033	0.532	Fallow	Jan. 1 to May 15
4-A	1.34	5.58	5	4	700	4.32	33.6	1.97	0.137	0.403	Oats	May 15 to July 15
4-A	1.34	5.58	5	4	700	1.07	0.0	0.51	0.038	0.477	Cowpeas	July 15 to Dec 31
4-A	1.34	5.58	5	4	700	6.43	10.0	2.80	0.079	0.461		Total for 1932.
2-C	4.37	3.66	2.93	0 to 4	2525	0.71	9.5	0.23	0.066	0.262	Cotton stalks:	Jan. 1 to May 15
2-C	4.37	3.66	2.93	"	2525	0.71	24.1	3.33	0.283	0.375	Winter Wheat:	May 15 to Oct 15
2-C	4.37	3.66	2.93	"	2525	0.71	4.5	0.05	0.043	0.173	Corn	Oct 15 to Dec 31
2-C	4.37	3.66	2.93	"	2525	0.71	17.0	Not Complete			Fallow	Total for 1932.
1-C	6.16	3.54	3.91	"	2350	6.43	24.1	3.33	0.283	0.375	Corn	Jan. 1 to May 15
1-C	6.16	3.54	3.91	"	2350	6.43	4.5	0.05	0.043	0.173	Fallow	May 15 to Oct 15
1-C	6.16	3.54	3.91	"	2350	6.43	24.1	3.33	0.283	0.375	Corn	Oct 15 to Dec 31
1-C	6.16	3.54	3.91	"	2350	6.43	4.5	0.05	0.043	0.173	Fallow	Total for 1932.

SUMMARY OF RESULTS OBTAINED

ON

THE RED PLAINS SOIL EROSION EXPERIMENT STATION

FROM 1929 to 1932 INCLUSIVE

Trends and conclusions for the Guthrie Station are based on observations and measurements collected over a four-year period. All runoff measurements are based on collections for a three-year period or less, and soil loss records are complete only for the years 1931 and 1932. This brief period of time must be borne in mind in making interpretations of results.

RESULTS

Experiment No. 1:-

1. The per cent of the rainfall which appears as runoff decreases as the vertical spacing between terraces increases, due to the increased opportunity for percolation.
2. Soil loss in tons per acre increases directly with the vertical spacing between terraces when the ground is bare, in fallow, or cropped to clean cultivated row crops.
3. When the field is cropped to close growing drilled crops, such as oats, the soil loss is not greatly influenced by the vertical spacing.

Experiment No. 2:-

4. The per cent of the rainfall appearing as runoff decreases to a small extent with the grade of the terrace.
5. The intensity of runoff decreases decidedly with decreased grade of terrace.
6. Yearly soil loss per acre is about one fourth as much on the level terrace as on the terrace of six inch grade per 100 feet.
7. The terraces with four and six inch grades appear to retain the desired grade in excellent manner so long as the outlet is protected from scouring, while the two inch and level grades are subject to irregularities produced by channel deltas.
8. Crop yields is lowered on the terrace with six inch grade by scouring and is lowered on the level terrace by drowning.

Experiment No. 3:-

9. Runoff in per cent of yearly rainfall is about twice as large from terraces located on the severely eroded land contained in Experiment No. 3, as from the terraces on new land.
10. Yearly soil loss from the terraces on eroded land is approximately twice that from the terraces on new land.
11. During severe storms the absorption capacity of the new soil is overtaxed and the variation between soil loss and runoff on eroded and virgin land is not equal to the yearly average. For lesser storms, the new soil is able to absorb the moisture at a rapid rate and the variation between eroded and virgin land often exceeds the yearly average.

Experiment No. 2:-

1. The gas tank of the inverted manometer is removed and the manometer is a small column with the grade of the barometer.
2. The manometer is removed and the manometer is a small column with the grade of the barometer.
3. The manometer is removed and the manometer is a small column with the grade of the barometer.
4. The manometer is removed and the manometer is a small column with the grade of the barometer.
5. The manometer is removed and the manometer is a small column with the grade of the barometer.
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9. The manometer is removed and the manometer is a small column with the grade of the barometer.
10. The manometer is removed and the manometer is a small column with the grade of the barometer.

Experiment No. 3:-

1. The manometer is removed and the manometer is a small column with the grade of the barometer.
2. The manometer is removed and the manometer is a small column with the grade of the barometer.
3. The manometer is removed and the manometer is a small column with the grade of the barometer.
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5. The manometer is removed and the manometer is a small column with the grade of the barometer.
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9. The manometer is removed and the manometer is a small column with the grade of the barometer.
10. The manometer is removed and the manometer is a small column with the grade of the barometer.

12. Crop yields from the terraces located on the virgin land of this experiment were from 31 to 150 per cent higher than those from the terraces on eroded land.

13. Reduction of crop productivity on the soil disturbed by the terracing operation practically disappears after the first two or three years of service to the terraces.

Experiments No. 4 and 5:-

14. Information thus far obtained upon level terraces with notoutlet on the eroded soil of the Guthrie farm dictates that they are not satisfactory because terraces of excessive height or extremely small vertical spacing are required, there is a serious decrease in crop yields due to drowning of crop in the channel and delay in harvesting operations, and wet terrace channels hinder the accomplishment of farm operations at the proper time.

15. For terraces located on virgin land, it appears that absorption takes place at a sufficiently rapid rate to prevent the necessity of unusually high terraces or close spacings.

Experiment No. 7:-

16. Cost of terrace construction will vary greatly with the experience, skill, intelligence, and vigor of the machinery operators.

17. Soil extremely dry and hard, or extremely moist will increase the cost of construction.

18. A vegetative covering that will clog the machinery tends to slow down the rate of construction.

13. The first time the proposed bridge is to be
built of this material will be in the year 1910
from the surface on eroded land.

14. The second time the proposed bridge is to be
built of this material will be in the year 1920
from the surface on eroded land.

Section No. 4 and 5:-

15. The third time the proposed bridge is to be
built of this material will be in the year 1930
from the surface on eroded land.

Section No. 6:-

16. The fourth time the proposed bridge is to be
built of this material will be in the year 1940
from the surface on eroded land.

Section No. 7:-

17. The fifth time the proposed bridge is to be
built of this material will be in the year 1950
from the surface on eroded land.

Section No. 8:-

18. The sixth time the proposed bridge is to be
built of this material will be in the year 1960
from the surface on eroded land.

19. Short terraces are more expensive to construct than long terraces due to the increased percentage of time spent in turns.

20. Cost of construction per mile of terrace, not including depreciation of machinery, will decrease as the size of the terracing machine is increased, provided sufficient traction power is always supplied.

21. It requires more time and labor to build a terrace in heavy clay than in a sandy loam soil.

22. Roots, rocks, sprouts, and stumps add materially to the cost of terracing.

23. It costs about twice as much to terrace cultivated land with small gullies as it does to terrace cultivated land of a uniform nature. This ratio rapidly increases with the number and size of the gullies.

24. Terracing costs secured on soil of one definite texture and workability will not be applicable to a soil of another texture and degree of workability.

25. On slopes of less than about four per cent, it is more economical to build terraces from both sides equally, but when the slope exceeds this amount it is cheaper to work from the upper side only.

26. The one way disc plow, using discs 26 inches in diameter, will build terraces equivalent to those built with the blade terracer in approximately the same number of rounds. Only one man is required to operate the unit of tractor and one way disc while two are required to operate the tractor and blade terracer. It is subject to a major disadvantage, however, in that it will not function efficiently on wet or very damp ground that may be easily worked with a grader.

19. Short terraces are more expensive to construct than

long terraces and are not so effective in preventing soil erosion.

20. The cost of constructing long terraces is less than that of short terraces.

21. The spacing of terraces should be determined by the slope of the land.

22. The width of terraces should be determined by the slope of the land.

23. It requires more time and labor to build a terrace in

heavy clay than in a sandy loam soil.

24. The cost of constructing terraces is less in sandy loam soil than in heavy clay.

25. The cost of constructing terraces is less in sandy loam soil than in heavy clay.

26. It costs about twice as much to terrace cultivated land

as it does to terrace uncultivated land of a uniform

slope. This is because the cost of building a terrace is less on a uniform slope than on a slope that has been cultivated.

27. The cost of constructing terraces is less on a uniform slope than on a slope that has been cultivated.

28. The cost of constructing terraces is less on a uniform slope than on a slope that has been cultivated.

29. The cost of constructing terraces is less on a uniform slope than on a slope that has been cultivated.

30. On slopes of less than about four per cent, it is more

expensive to terrace than to plant with trees or shrubs.

31. The cost of constructing terraces is less on a uniform slope than on a slope that has been cultivated.

32. The cost of constructing terraces is less on a uniform slope than on a slope that has been cultivated.

33. The cost of constructing terraces is less on a uniform slope than on a slope that has been cultivated.

34. The cost of constructing terraces is less on a uniform slope than on a slope that has been cultivated.

35. The cost of constructing terraces is less on a uniform slope than on a slope that has been cultivated.

36. The cost of constructing terraces is less on a uniform slope than on a slope that has been cultivated.

37. The cost of constructing terraces is less on a uniform slope than on a slope that has been cultivated.

38. The cost of constructing terraces is less on a uniform slope than on a slope that has been cultivated.

Experiment No. 8:-

27. The major objections to existing farm implements when applied to terraced land are lack of self stabilization on steep slopes, lack of flexibility to accomodate sudden changes in surface, and impossibility of quick and ready adjustment.

Experiment No. 9:-

28. The ridge and channel yields individually, for terraces 4-B to 9-B, were higher than the interval yield in 1931, but in 1932, the channel yield was slightly below the interval yield. This was caused by ponds which formed at old gully crossings in the channel and remained there during the long series of spring rains, thus drowning out much of the crop.

Experiment No. 10:-

29. Low dams are more successful than high dams since the water falls a shorter distance below the dam and there is less tendency to erode the bottom of the gully. The pressure of water above high dams is sufficient to force out silt that has accumulated in the open spaces of the more porous dams. From the standpoint of both economy and successful operation, it is believed that a height of about 2 feet is the most satisfactory for check dams in small gullies.

30. The greater the flow of water in the gully, the stronger should be the anchorage of the dam. The flow of water in the gully depends upon the size of the drainage area. Brush dams without anchorage have not been found satisfactory. In small gullies with a very limited drainage area some form of light anchorage such as a few loose rocks should be placed on top of the brush.

Experiment No. 11-

11. The object of this experiment is to determine the effect of the rate of flow of water on the rate of sedimentation of a suspension of fine sand in water.

The object of this experiment is to determine the effect of the rate of flow of water on the rate of sedimentation of a suspension of fine sand in water. The object of this experiment is to determine the effect of the rate of flow of water on the rate of sedimentation of a suspension of fine sand in water.

Experiment No. 12-

12. The object of this experiment is to determine the effect of the rate of flow of water on the rate of sedimentation of a suspension of fine sand in water. The object of this experiment is to determine the effect of the rate of flow of water on the rate of sedimentation of a suspension of fine sand in water. The object of this experiment is to determine the effect of the rate of flow of water on the rate of sedimentation of a suspension of fine sand in water.

Experiment No. 13-

13. The object of this experiment is to determine the effect of the rate of flow of water on the rate of sedimentation of a suspension of fine sand in water. The object of this experiment is to determine the effect of the rate of flow of water on the rate of sedimentation of a suspension of fine sand in water. The object of this experiment is to determine the effect of the rate of flow of water on the rate of sedimentation of a suspension of fine sand in water.

Experiment No. 14-

14. The object of this experiment is to determine the effect of the rate of flow of water on the rate of sedimentation of a suspension of fine sand in water. The object of this experiment is to determine the effect of the rate of flow of water on the rate of sedimentation of a suspension of fine sand in water. The object of this experiment is to determine the effect of the rate of flow of water on the rate of sedimentation of a suspension of fine sand in water.

31. The sides of the gully at the location of dams should be protected against washing to the top of the bank or at least as high as the water in the gully is expected to rise. The most common failure of check dams consists of erosion at one or both ends of the dam.

32. An apron should be built below impervious dams to prevent the falling water from eating back under the dam. This is also a very common cause of failure of check dams.

33. For the best results the top of one dam should be placed at the level of the bottom of the dam above. The results of the experiments showed that it would be possible to place the dams further apart than this since a fill occurred the total distance between the dams in Gullies F and G. However, it is believed that the better results will be obtained where the rule is observed.

34. The check dams should not reduce the cross-section of the gully sufficiently to cause the water to overflow the banks, as this usually results in the erosion of a new parallel gully down the slope.

35. More rapid filling above a brush dam occurs where the bottom of the gully is covered with grass, straw or other similar material, the finer brush placed next to the straw, and the larger brush placed and packed so as to reduce open spaces in the brush to a minimum. This method tends to prevent erosion along the sides or bottom of the gully which results in washing out a hole and undermining the dam.

Experiment No. 12:-

36. A cover of woods and brush insures percolation of rain-water into the soil, thus preventing runoff and erosion.

21. The sides of the gully at the junction of the main
the water is the only one exposed to the air. The water is
at about the same level of the water in the main gully.
The water is the only one exposed to the air. The water is
at about the same level of the water in the main gully.
The water is the only one exposed to the air. The water is
at about the same level of the water in the main gully.

a very common cause of failure of check dams.

22. For the best results the top of the dam should be placed
at the level of the bottom of the main gully. The water is
at about the same level of the water in the main gully.
The water is the only one exposed to the air. The water is
at about the same level of the water in the main gully.
The water is the only one exposed to the air. The water is
at about the same level of the water in the main gully.

the water is the only one exposed to the air.

23. The check dams should not reduce the transportation of the
water to overflow the banks, as this usually
results in the formation of a new gully from the top.

24. The water should be placed in a basin or a pool at the
bottom of the gully. The water is the only one exposed to the air.
The water is the only one exposed to the air. The water is
at about the same level of the water in the main gully.
The water is the only one exposed to the air. The water is
at about the same level of the water in the main gully.
The water is the only one exposed to the air. The water is
at about the same level of the water in the main gully.

Attachment No. 12.

A cover of wood and brush frames
is placed over the well, the opening being
at the top of the well.

37. Large gullies, when left unhindered in abandoned grass lands, tend to enlarge from year to year and will in time completely consume the area.

38. Runoff in per cent of rainfall, from gullied grass lands is much higher than runoff from areas with unbroken cover and is less than that from cultivated areas.

39. Percentage of rainfall appearing as runoff on cultivated areas with level terraces is less than the runoff from areas with graded terraces or from fields not terraced.

40. Soil loss from Plot 13 was at 9 times the rate of loss from a terrace one-half mile long with a variable grade from 0" to 4"/100'. 12.5 times the rate of loss from a terrace 1,500 feet long with a constant grade of 4"/100'. 25 times the rate from a level terrace 1,500 feet long and at a rate varying from 33 to 74 times the loss from a short level terrace under exactly comparable conditions.

37. Let the gullies, when left unimpaired in

the lands, tend to enlarge from year to year and will in time com-
pletely consume the area.

38. Runoff in per cent of rainfall, from gullied areas

is less than runoff from areas with unbroken cover and is
less than that from cultivated areas.

39. Percentage of rainfall of runoff as runoff on culti-

vated areas with level terraces is less than the runoff from areas with
level terraces or from fields not terraced.

40. Soil loss from first 13 was at 3 times the rate of 10

from a terrace one-half mile long and 1/2 mile wide. The rate of soil loss
is 1/3 times the rate of loss from a terrace 1/2 mile long and 1/2 mile wide.

From 4 to 100, 20 times the rate from a level terrace 1,000 feet long
and 1/2 mile wide. The rate of soil loss from a terrace 1/2 mile long and 1/2 mile wide

was under exactly comparable conditions.

